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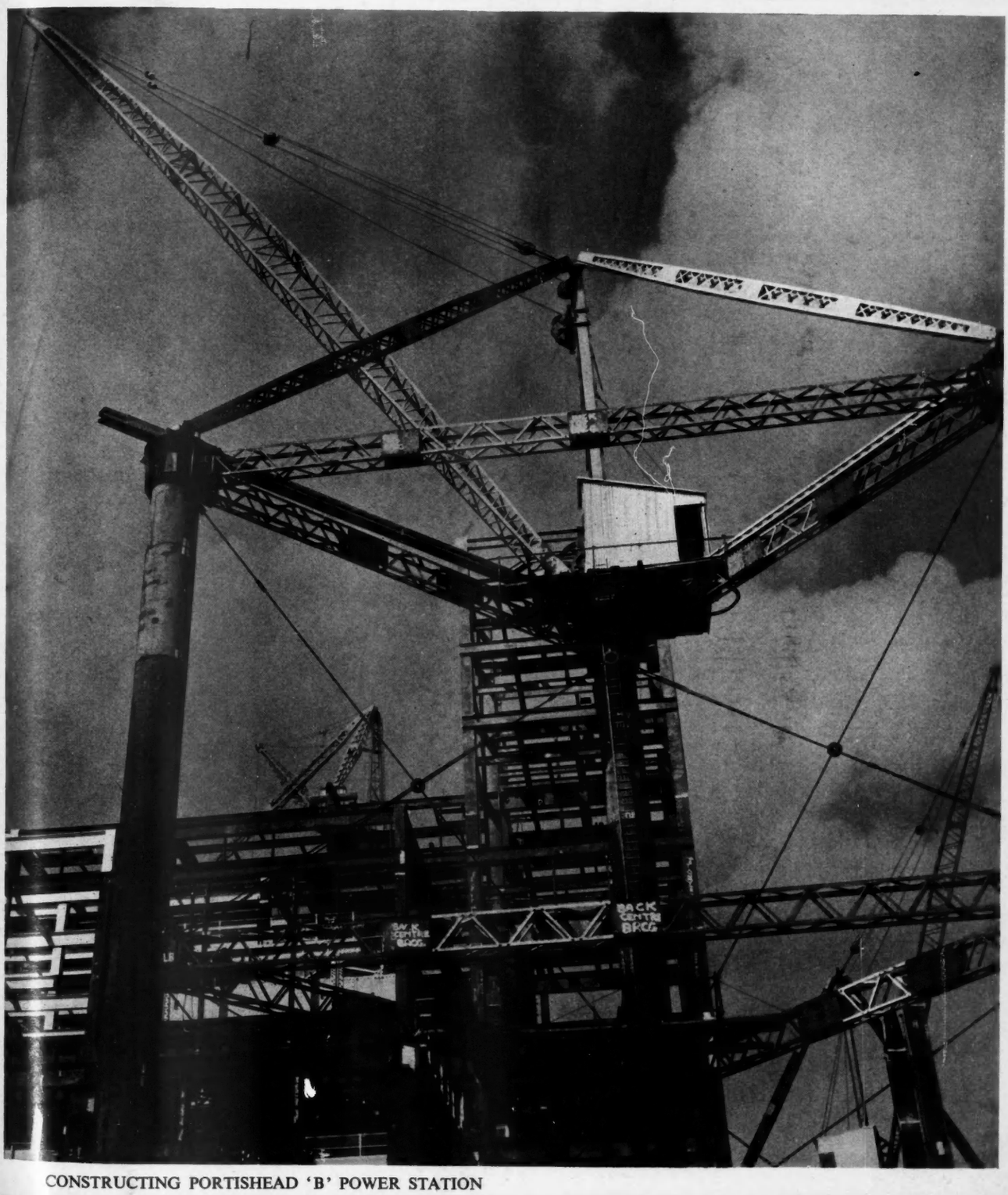

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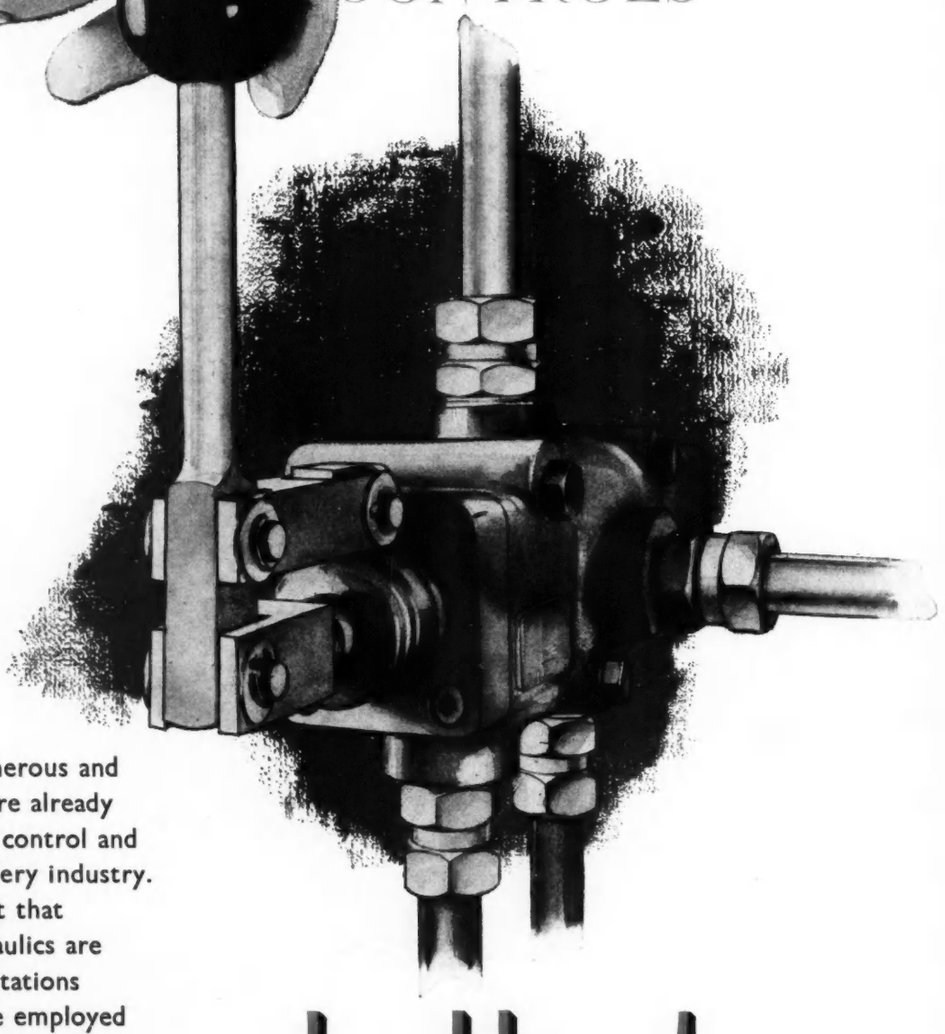

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ENGINEERING

An Illustrated Weekly Journal

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DEGREE MEN

A FEW months ago a member of ENGINEERING's editorial staff visited a works in England to see a machine which has since been justifiably hailed as a pioneer in its field, a great engineering achievement. The patient research and design which had gone into it were the work of a group of young men who were very highly qualified academically but whose previous practical experience as engineers would not have impressed many directors or works managers. They were high-level degree men. Our representative took the opportunity to speak to a fitter who was working with a file on a second machine of the same design. The fitter recalled how he and his "mates" had been doubtful (to translate his remarks into printable English) of the ability of these young university fellows to design a practical machine, but now the prototype had passed its tests, and orders were coming in for as many as they could build, he was clearly unable to find words adequate to express his admiration.

Before the point of that story becomes linked with the point of this article, let full credit be given to the directors of the firm in question: they risked considerable capital and several years' work of some of their best staff. Being directors, they would not have taken the risk unless they had had the vision and understanding to foresee the probable results. Fundamentally, it was the directors who were responsible for the success of that machine.

The 1954 Sir Alfred Herbert Paper was presented to a meeting of the Institution of Production Engineers at the recent Production Conference by the Earl of Halsbury. As managing director of the National Research Development Corporation, Lord Halsbury is well qualified to observe the chain of development between Government-financed research and the practical use that industrial firms make of it. His Corporation takes over when the research establishments have done their work, and is then responsible for ensuring that the results are passed on to firms who will best develop them commercially. He believes that "we ought to think of university titles as dependent upon whether academic training has lasted three, five or seven or more years. The corresponding degrees would be those of Bachelors, Masters or Doctors, for I do not think a Doctorate should normally be won on less than seven years' work. All three produce valuable types of student and we need them all, though for different purposes. In the engineering sciences the Bachelors would be the raw material for careers which are to be concerned with maintenance, line production, or design in the field of standard practice. The Masters would be the raw material for the specialist teams, research workers, designers in the field of essential novelty and production. Among them I would include those qualifying with double degrees in, say, economics superimposed on engineering, or chemical engineering superimposed on engineering or chemistry. The seven-year men would provide the thinkers and theorists."

The young engineer with a bachelor's degree should have no difficulty in finding his niche in industry, but there may be difficulties for one who has spent a total of five or seven years at a university. His age is high in relation to his lack of day-to-day industrial experience. It is not so easy for him to make the break with the scholastic world, and his employer, being prepared to use high academic attainments, may too readily expect maturity of personality. Lord Halsbury suggests that the difficulty, so far as the student is concerned, may be due less to a positive expectation of privileged status in his future work than from ignorance that a term of life is drawing to an end, and that in the past he has been privileged. A young man suffering from such ignorance could easily be spoiled and warped, he believes, by unsympathetic or clumsy handling or the wrong kind of rude awakening in the critical year or two following graduation. Personality, he pointed out, is not rigid at 26 years of age; it is merely a little less plastic, so that adjustments may take a little longer.

It is the economic factor, however, to which Lord Halsbury directs more attention. A student who extends his period of education beyond the ordinary degree is justified in doing so because he hopes to be of greater value to the community. If he postpones his earning capacity beyond the average age, he can reasonably expect a commensurate return on the investment of his time and perhaps his parents' money. If the State, or another third party, is to finance his further education, it is right that he should submit to some initial abstinence for the sake of a later advantage. Lord Halsbury states the position in this way, and concludes that the choice made by young engineers should be free to reflect some state of market equilibrium between the supply of and demand for people with different talents. Starting salaries should differentiate between the three-year, the five-year and the seven-year training periods, though the same level of professional status (as determined by the professional institutions) should be reached in the end. Only by this approach will the right types of engineers, in the right numbers, be available for the more exacting and rewarding work of the future.

Weekly Survey

THE RAILWAYS

The railways reorganisation scheme which the British Transport Commission have prepared for Parliament's approval gives practically no information on the possible future development of the civil and mechanical engineering branches. This is not altogether surprising, since the White Paper on the scheme concentrates mainly on the proposed establishment of Area Authorities, the members of which would "bring to the area organisations a close knowledge of public and business requirements in respect of transport. They would also bring in new ideas on methods and practices. They would improve personal contact with staff. They would substantially assist the Commission in the fulfilment of their task by relieving them of their work."

A possible pointer to future policy is contained in a sentence relating to the preparation of net revenue accounts: "There is no doubt that the efficiency of British Railways as a whole has been vastly increased by the unifications achieved in the last fifteen years . . ." This statement would seem to suggest that some part, at least, of the locomotive standardisation policy will be continued. The subject may be discussed in Parliament when the White Paper is under consideration, but the Commission would undoubtedly prefer to be left to work out the best solution themselves, in consultation with the present Regions or the future Area Authorities.

The reorganisation scheme, as drafted, is intentionally fluid. The White Paper concludes with the statement that "it might be that some activities now controlled regionally could with advantage be separated and formed into central services, e.g., the shipping services and the work in the main mechanical engineering workshops. These are not matters, however, on which the Commission can say anything at this time; there are arguments for and against in each case which will require detailed study. It is for reasons such as these that the Commission desire that the present scheme should be as flexible as possible to permit development on the most efficient and economical lines."

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UNIVERSITIES AND COLLEGES

Outside London, where the Imperial College of Science and Technology is to be given special support, the main centres which the Government have chosen for the further development of higher technological education are Glasgow, Manchester, Leeds and Birmingham. The Chancellor of the Exchequer, Mr. R. A. Butler, announcing the plans on July 13, said that provision had also been made for development elsewhere, but "to increase the number of university institutions concerned with higher technological education would involve a dispersal of effort which the Committee does not advise." In giving his approval to this policy of the University Grants Committee, the Chancellor was undoubtedly right. The engineering centres of Britain are the country's life-blood to-day.

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NEW SEAMLESS-TUBE PLANTS

It was announced last week that the new Mannesmann tube plant at Belo Horizonte in Brazil is to commence operations at the end of this month. To start with, only 2-in. tubes will be manufactured but it is hoped to extend the range to 7-in. and 8-in. tubes by the spring of 1955. This new works is only one of a number of new seamless-tube mills which are being erected throughout the world. For a number of years now the mild-steel seamless-tube industry has been trying to catch up with the rate of expansion of the world petroleum industry. Seamless-tube capacity has been expanding in several of the highly industrialised countries which already have a seamless-tube industry and also in countries which are less industrialised but some of which have an indigenous oil industry.

The Petroleum Administration for Defence in the United States announced early in 1953 that 500,000 tons of new seamless-tube capacity would be installed in that country. A new mill has recently been erected in Western Germany to supply markets in south-east Europe, and there is reported to be a large-scale renovation programme in hand in Japan. Capacity also continues to be increased and modernised in this country. In Belgium, about 60,000 tons a year of capacity is being added to the Flemalle-Haute Works of the S.A. des Usines à Tubes de la Meuse to make tubes over 9 in. in diameter.

In countries which are less highly industrialised, new plants are also being installed. The Dalmine concern in Italy is taking an interest in a new plant in Mexico and one in Argentina. The former will have a capacity of about 60,000 tons, and the latter 80,000 tons a year. A new mill with a capacity of 20,000 tons a year has just begun operations in Yugoslavia. There are reports, too, that Israel is going to install a new Mannesmann plant and that the first tentative plans have been made in India by the Tata Iron and Steel Company.

The expansion in seamless-steel tube capacity throughout the world has thus reached an interesting stage. The world oil industry is likely to absorb increasing quantities of seamless and welded tubes for some time to come, for the oil-well development programme in the United States is still increasing and pipeline requirements both for oil and natural gas continue to expand. If the expansion plans of the Petroleum Administration for Defence have been carried out in the United States there must be something in the order of a million tons of extra capacity planned for the next few years. It remains to be seen whether the American recession has slowed up the demand for seamless tube for the oil industry sufficiently for capacity to temporarily exceed demand. On the whole, it does not look as though a slackening in the activity of the American oil industry would do more than produce a very temporary surplus of capacity. As long as the Americans, and to some extent others, continue to drill more and deeper oil-wells and to build longer pipelines, the prospects for the seamless-tube industry are good. The mechanical uses of seamless tubes are important but the oil industry takes about 40 per cent. of the world's output and it is this industry which is likely to dictate the trend of demand for some time to come.

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EASIER HIRE PURCHASE

The relaxation last week of hire-purchase controls in force since 1952 will be welcome in many branches of the engineering industry, but particularly to manufacturers of electrical consumer goods such as radio and television sets, refrigerators and washing machines. It should help to maintain sales at a time when they normally begin to drop with the seasonal fall in demand. Makers of television receivers, who a month ago feared they might not be able to sell a million sets this year, may now equal last year's record sales of nearly 1·5 millions.

The measure can, however, scarcely have been prompted by any need to stimulate consumer demand. Sales of most of the goods affected are already running considerably above the 1954 levels, and the total volume of hire-purchase business is probably nearly 40 per cent. higher. Statistics supplied by Hire Purchase Information, the largest organisation to record transactions, unfortunately relate only to contracts for motor vehicles and cycles, industrial and agricultural machinery, aircraft and caravans, but they show that 270,000 contracts were registered in the six months to June, 1954, compared with 190,000 in the first half of 1953.

A major influence behind the Treasury decision may have been merely the desire to cancel an Order which, due to the exploitation of loopholes, was becoming ineffective, at least in part. The decision in the recent case of *Regina* v. *Proffitt*, for example, showed that in certain conditions, hiring agreements could be extended beyond the limit of 18 months and that a deposit of 33⅓ per cent. need not be obtained. In any case, the official removal of these restrictions will scarcely lead to unlimited consumer credit. Unless the hire-purchase companies can themselves obtain freer credit, many of them will find it difficult to grant much easier terms. The Treasury have not withdrawn their instructions issued at the end of 1951 that the banks should freeze their advances to hire-purchase companies at the existing level and that the Capital Issues Committee should refuse applications from these companies to raise fresh capital. This has not prevented small new finance houses springing up with capitals below the restricted level of £50,000. These small concerns often do a useful service in specialising in the comparatively small loan market in which the larger houses are less interested, but the outlook for many would not be bright if easier credit conditions enabled the larger houses to extend their business.

For the present, those trades which do their hire-purchase business through the independent finance houses (large and small) cannot expect to enjoy the full benefits to be obtained from the present relaxation of controls. In the motor-vehicle and motor-cycle trades, for example, it is not expected that deposits will commonly be reduced below 25 per cent., or the period of repayment extended over more than two years. Domestic electrical goods, marketed by multiple stores operating their own hire-purchase schemes may, however, benefit much more. In some cases deposits have already been abolished and the repayment period extended to at least two years.

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BRAZILIAN TRADE

Two items of news from Brazil last week, capped by a feature article by Sir George Nelson in *The Times* of July 14, make mixed reading. Sir George returned from South America with a probable large rail re-equipment contract for his company and a message of encouragement for British exporters: "Her (Great Britain's) contribution to Latin-American prosperity will lie in supplying power-generating plant, locomotives, rolling stock, vehicles and modern machinery for agriculture and industry, and radio and telecommunication equipment." His next sentence, "Another main contribution will be in finance and credit," is likely to raise a few wry smiles among those once-bitten, and may, perhaps, fail to receive much support from the Treasury, whose officials may not be easily convinced that hard-won United Kingdom savings should go to finance those who raised objections to almost every proposal for a solution of the trade impasse in which Britain finds herself with Brazil and the Argentine. The news of a better atmosphere following Sir

George Nelson's visit was pleasing, but an announcement from Essen the following day referring to "a series of German steel projects in Latin America, notably in Brazil," that are nearing fruition, was less pleasing. This mentioned the Mannesmann tube project (referred to in our note on new seamless-tube capacity) and the purchase by the Kloeckner concern of Duisburg of a controlling interest in Fero a Azo in Brazil with a view to erecting a new integrated steel plant at Vittoria, some 300 miles north of Rio.

Sir George Nelson points out in his article that "Germany regards South America as her traditional market, and she is doing everything she can to recover her old position. She works with immense drive . . ." It is good to see the successful head of an outstandingly successful company write of the need for energetic and enlightened salesmanship, backed up by intelligent and cultured public relations in the right language. His plea for facilities in British universities and in industry for training Latin-American engineers is timely. Sir George's conclusions were also those of the F.B.I. team who preceded him by some months, and who made similar recommendations (ENGINEERING, June 4, page 706). British engineers should not forget that it was Sir George Nelson, one of their leaders, who reminded them that "German business men are quick to act and quick to send technicians when these are required."

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PUNJAB WATER

For India, the opening of the Bhakra canal system last week had a deep significance. The Indians, who despite limited resources are pushing resolutely forward with their development programmes, deserve every credit for their achievement, as also do the British irrigation engineers who planned the project. About 3,400 million cub. ft. of earth had to be excavated for the construction of the main canal and branches 677 miles long, and distributories 3,958 miles. These will irrigate nearly 4 million square miles of once-arid land which should now yield crops to an annual value of about 1,000 million rupees.

Unhappily, the scheme is a source of international dissension. The Pakistan Government has described the withdrawal of water from the River Sutlej as a gross violation of international agreements. Charges and countercharges confuse a difficult situation, arising from the arbitrary drawing of the political frontier. The Punjab is a geographical unit which demands an integrated development plan. In Pakistan, as in India, major works are being carried forward with commendable zeal, but resources are limited and those schemes which offer the greatest immediate advantage to Pakistan do not necessarily fit in well with the Indian plans.

Discussions between both countries held intermittently since May, 1952, under the auspices of the World Bank have so far failed to produce agreement. Proposals by the Bank for a division of the Indus waters were rejected by Pakistan in June. These recommended that the entire flow of the Western rivers of the Indus system – the Indus, Jhelum and Chenab – should be available to Pakistan, leaving the Ravi, Beas and Sutlej to India. These carry only one-fifth of the waters of the Punjab, and the loss to dependent areas of Pakistan would be made good by a system of canals bringing water from the Indus and Jhelum. Some of this canal system has already been built but there is understandably less sense of urgency about its completion than there is over similar works in India. Prior to partition, most of the irrigation work in the Indus basin was undertaken in what is now Pakistan, where there are now 18 million irrigated acres and 66 million acre-feet of irrigation water. On the other hand, India had, prior to the opening of the Bhakra canal, only 5 million irrigated acres and 9 million acre-feet of irrigation water.

A compromise solution to the difficulties will, it is hoped, be found; but so long as engineers who can overcome formidable physical obstacles in bringing water to desert places, are hampered by political barriers, it is hardly likely to be an ideal one.

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ENTERPRISE IN AIR CHARTERING

One of the significant developments in air transport announced earlier this year was the acquisition of certain of the independent air operating concerns by certain of the large shipping companies. Britavia, for example, is now controlled by the General Steam Navigation Company, an associate of the Peninsular and Oriental Steam Navigation Company, and at about the same time a controlling interest was taken in Airwork by Furness, Withy. More recently, the Blue Star Line has taken up an interest in Airwork as well. Such moves by the shipping companies make it plain that they are determined to have an interest in air transport even though the scheduled passenger lines are nationalised. The financial strength and expertise of these companies are now forces to be reckoned with.

Meanwhile, competition for air-charter work continues unabated. Britavia, whose subsidiary Silver City Airways has done so much to expand the air-ferry service across the English Channel and so justify the new air terminal at Ferryfield (described on page 94 of our last week's issue), has begun trooping operations to Cyprus and Kenya. The flights to Nairobi began last week and those to Cyprus have started this week. The company is using the four-engined Hermes bought recently from B.O.A.C. Another development this month has been for Skyways, of London, to negotiate a charter arrangement with an independent German civil aviation company by which the aircraft will be flown by British pilots under the auspices of the British company. These plans will have to be approved, however, by the tri-partite Allied Civil Aviation Board. Two forwarding companies, Kühne and Nagel, and Karl Prior, own the majority interest with Skyways taking a substantial minority. The company will begin operations with three D.C.3's.

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CAR MERGERS HERE AND ABROAD

The decision not to go ahead for the time being with the financial merger proposed last March between the Standard Motor Company and the Rover Company is an indication that both are finding the pressure of rising output more than sufficient to absorb their full attention. No volume producer of cars is likely to be very concerned with the immediate future, even if a seasonal fall in demand takes place this summer; order books for nearly all models are very full indeed. Standard's production during the first six months of the year was a record, and output in June, 632 cars and tractors a day, was the highest in the history of the company. A feature of Standard's recent achievements has been the excellent handling of the company's resources by the new managing director, Mr. A. S. Dick. The need to strengthen the company's top management, which would have been one of the more obvious and immediate results of the merger, now appears far less urgent.

Mergers are a fashionable subject in the United States as well as here. While British car output soars, the difficulties of the smaller manufacturing concerns in the United States continue. A number of moves towards closer integration of their manufacturing capacity have taken place since our last mention of the subject (ENGINEERING, June 25, page 802). American Motors Corporation (Hudson-Nash) are moving the manufacture of Hudson cars to the Nash plants in Wisconsin, and endeavouring to fill the Hudson plant in Detroit with Government orders and component manufacture. Willys Motors have completed the transfer of Kaiser car manufacture from Willow Run to the Willys plant in Toledo. The Packard Motor Car Company have leased a plant in Detroit from the Chrysler Corporation to make their own bodies, and there are persistent rumours of an impending merger between Packard and the Studebaker Corporation. This would produce a concern of about the same strength and size as did the merger last May of Kayser and Wyllis production facilities.

British car makers will doubtless return to the concentration of production facilities when the present boom is over. Until then the wish to increase production will doubtless take precedence. Production during the first six months of the year was running at the rate of about 730,000 cars a year, which is approaching the figure claimed by the industry during the steel shortage as its minimum capacity (800,000). Production of commercial vehicles is also running at a high level, though about 5 per cent. below the 1950 peak. Output of vans, which accounted for the bulk of the increase, was about 6 per cent. above the peak reached last year.

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SIMPLE RESEARCH TOOLS

There is a tendency to-day to regard costly and elaborate equipment as essential to successful research and development work. This is especially noticeable in industries such as the aircraft industry where the pace of development is taxing man's ingenuity to the limit. It is therefore noteworthy that some of the most advanced work in hydrodynamic design is being carried out rapidly and successfully in the test department of an aircraft firm (Saunders-Roe Limited) with equipment built largely from redundant materials and with instruments of notable simplicity. A description of the Saunders-Roe hydrodynamic test facilities, which are used not only for testing water-based aircraft models but also for a wide variety of marine craft, is published in this issue.

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THE FIRST COLOUR TELEVISION

Four weeks ago, in a Weekly Survey note, we stated that "British manufacturers, with comparatively little publicity, have gone a long way with the development of colour television." We praised their work; even so we did not give all the credit that was due. J. L. Baird, a correspondent has pointed out, gave the first public demonstration of colour television as long ago as 1927. The Marconi demonstration in May of this year showed the first compatible colour television to be seen in this country. Their wide band system, the design of the two-tube camera and the flying-spot colour tele-cine, are all the result of original work in this country.

Obituary

SIR ERNEST W. PETTER

Early Motor-Cars and Oil Engines

Twenty years ago there was no more colourful personality in British engineering than Sir Ernest Willoughby Petter, whose death, we regret to record, occurred on Sunday, July 18. Seventeen years ago, however, he relinquished all ties with this country and settled in Victoria, British Columbia, where, he announced, he intended to spend the rest of his life. He did, in fact, spend 16 years there, but eventually decided to return to England. He did so at the end of 1953, making his home in New Milton, Hampshire, and it was there that he died.

Sir Ernest, who received his knighthood in 1925, was born on May 26, 1873, one of the 15 children of James B. Petter, head of the firm of James B. Petter and Sons, general engineers, of the Nautilus Works, Yeovil, Somerset. His general education was received at private schools and at Mount Radford School, Exeter, which he left in 1890 to enter upon a five years' apprenticeship in his father's works. There, with his twin brother, the late Mr. Percy W. Petter, he interested himself in the development of internal combustion engines, at first with the idea of applying them to road vehicles. It was in 1895 that the brothers constructed a motor car which is believed to be the first British-built vehicle propelled by an internal-combustion engine, though the Butler car of 1878 would seem to have preceded it. Several of the type were made, but soon it became evident that there was a wider market for the engine in agriculture and general industry, and eventually the motor-car side of the business was abandoned.

In 1900 Ernest Petter was appointed London manager of the company, but in the following year he was recalled to Yeovil to act as joint managing director with his twin brother. At the end of 1903 he was made general manager, and immediately set about reorganising the works and equipping it with new plant to produce Petter oil engines in quantities. In subsequent years other types were produced, with considerable success, but it was the single-cylinder Petter oil engines, made in 3-h.p., 5-h.p. and 8-h.p. sizes, which really established the business. They were simple and substantial, and were widely advertised, so that a flourishing business was built up on them, mainly based on their agricultural applications. By 1912, it had outgrown the capacity of the original works. A new site was acquired, therefore, on the outskirts of Yeovil, where the present Westland Works was erected. Previously, only four-stroke engines had been made, but the increased capacity of the new works enabled new types to be developed, using the two-stroke cycle, and eventually the production of four-stroke engines was discontinued. After some years of experimenting, production was concentrated on three types, namely, the single-cylinder engines, from 1½ h.p. to 5 h.p., with magneto ignition, which were mainly sold for agricultural purposes; hot-bulb engine, in sizes ranging from 5 h.p. to 36 h.p., which was started by a cartridge system of ignition; and airless-injection Diesel engines, with various arrangements of cylinders, which were made in sizes from 25 h.p. to 400 h.p.

The needs of the 1914-18 war caused the brothers to launch out into a different field, that of aviation. Additional plant was put down for the construction of aircraft and a considerable tract of land was acquired, adjoining the works, for use as an aerodrome. Many types of aircraft were designed and made there, including three or four for private use, the Wessex for passenger work, a small bomber known as the Witch, the Westland interceptor fighter, and, most numerous of all, the Wapiti fighter, fitted with a Bristol Jupiter engine. After the war, this branch of the business became rather less important, though it has since revived after being absorbed into the organisation of Thos. Firth and John Brown, Limited, of Sheffield. Ultimately, the oil-engine business also changed hands, being taken over by the Vickers interests, who transferred the manufacture of the larger engines to Ipswich. In 1937, both Sir Ernest and his brother, who were then chairman and vice-chairman, respectively, resigned their positions on account of increasing age, the late Mr. A. P. Good taking over the chairmanship. It was then that Sir Ernest decided to emigrate to British Columbia. Some five years earlier, the brothers had developed a small desk calculating machine, mainly the work of Mr. P. W. Petter. It was called the " Petometer " and was designed to sell at the modest figure of 20 guineas. Only a few were made, however, and the machine never went into quantity production.

Sir Ernest was active in many directions apart from the management of his works. He was President of the British Engineers' Association in 1923-24 and again in the following year, and was a member of the Executive of the Federation of British Industries. He was elected to the Institution of Mechanical Engineers as an associate member in 1900 and was transferred to the grade of Member in 1904. He served for several periods on the Council of the Institution, to which he was first elected in 1921, and was a Vice-President when he retired from it in 1937. He was twice a candidate for Parliament, but was unsuccessful on both occasions. As a young man, he had intended to read for the Bar, a course which proved impracticable on the grounds of family economics; as has been stated, he was one of a family of 15. It may be doubted, by those who knew him, whether he had the capacity for judicial detachment that is desirable in a barrister. His was a more ebullient nature, which found a much more effective outlet in creative industry, where his name is not likely to be forgotten.

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MR. EDWARD THOMPSON, O.B.E.

Chief Mechanical Engineer of the L.N.E.R.

Mr. Edward Thompson, O.B.E., who died at Brymbo, Wrexham, on July 15 aged 73, succeeded the late Sir Nigel Gresley as Chief Mechanical Engineer of the London and North Eastern Railway in 1941.

During his five years' tenure of the office, Thompson's main work was in rebuilding and modifying existing locomotives, rather than the production of new designs. His new designs, however, included the B1-class 4-6-0 mixed-traffic locomotives (introduced in 1942), and the L1-class 2-6-4 tank engines (1945). Where Gresley favoured three cylinders and the use of conjugate valve gear for the inside cylinder, Thompson preferred the simplicity of two cylinders and, where three cylinders had to be retained, the use of separate sets of valve gear. In that, it may be noted, he foreshadowed the standard practice of British Railways. Gresley's original Pacific of 1922, " Great Northern," was rebuilt in 1945, when the conjugate valve gear was eliminated and a higher boiler pressure was introduced. In the same year Thompson replaced the three cylinders of Gresley's K3-class 2-6-0 mixed-traffic engines by two. During previous years he had rebuilt a 0-8-0 tender engine in tank form, thereby releasing the tenders for use with another class (this was in 1942, when economy in the use of steel was important); rebuilt the P2-class 2-8-2 as a Pacific (1943); built four engines of the V2 class as Pacifics instead of the usual 2-6-2 arrangement; and rebuilt some of the W.D. 2-8-0 engines which were still in service since the first World War.

Edward Thompson was born on June 25, 1881, the only son of F. E. Thompson, an assistant master and later governor of Marlborough College, where he was subsequently educated. He went to Pembroke College, Cambridge, in 1899 and took the Mechanical Science Tripos. In 1903 he entered the Beyer, Peacock works as a pupil and the following year went to the running department of the Midland Railway at Derby. From 1905 to 1906 he was on the staff of the Royal Arsenal at Woolwich but then returned to railway work in the Hull running shed of the North Eastern Railway. He became assistant divisional locomotive superintendent at Gateshead in 1909.

Three years later, Thompson was appointed carriage and wagon superintendent of the Great Northern Railway and in March, 1916, returned to the Royal Arsenal at Woolwich on war service. In December of the same year he proceeded to France, where he was attached to the Headquarters Staff of the Director-General of Transportation, attaining the rank of Lieut.-Colonel, R.E., and being twice mentioned in dispatches and appointed O.B.E. On his demobilisation in March, 1919, he resumed his work with the Great Northern until his return to the North Eastern in October, 1920, when he was appointed carriage and wagon works manager at York. With the formation of the L.N.E.R. in 1923 he was given a similar post for the whole of the North Eastern Area.

Thompson's next appointment was that of assistant mechanical engineer, Stratford, in 1927, becoming mechanical engineer there in 1930. He returned to the North Eastern Area as mechanical engineer of that area in 1934. Five years later he became mechanical engineer, Southern Area (Western Section) and in 1941 on the death of Sir Nigel Gresley he was appointed Chief Mechanical Engineer of the L.N.E.R. He retired on June 30, 1946.

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MR. T. F. LISTER

Management of Electrical Engineering

We regret to record the death of Mr. T. F. Lister, which occurred at Weybridge, Surrey, on Tuesday, July 13, at the age of seventy-one.

Thomas F. Lister was born in Yorkshire and received his engineering training at the Halifax Technical School. In 1901 he joined the staff of Ferranti, Limited, at Hollinwood, but after a short time was transferred to the contracts department of the firm in the London office. Four years later, after being with the General Electric Company, Limited, for a few months, he received an appointment with the British Westinghouse Electrical Manufacturing Company (now the Metropolitan-Vickers Electrical Company, Limited) in Manchester, and during his 20 years' service with that firm was at first engaged in the large machine division and in the switchgear, transformer and meter departments. During the first World War he was in charge of the deep-sea mining and magneto departments and subsequently became the first superintendent of the production department, which covered the whole of the Trafford Park works.

In 1925 he was appointed manager of the Hackbridge Electric Construction Company, Limited, Walton-on-Thames, and a year later manager of

the Hewittic Electric Company, Limited. He became a director of both companies in 1931 and managing director in 1944, being elected chairman and managing director in 1946. In 1947-48 he was made chairman and managing director of the Hackbridge and Hewittic Electric Company group, but retired from the position of managing director in 1954, although he remained chairman. He was also managing director of the Switchgear Construction Company, Limited.

Mr. Lister had a long association with the work of the British Electrical and Allied Manufacturers' Association and was chairman of its Council in 1951 and 1952.

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Mr. E. F. MORONEY

Ship Surveyor

We have learned only recently, with much regret, of the death on June 30 – within a few days of his 80th birthday – of Mr. E. F. Moroney, formerly senior engineer and ship surveyor for the Board of Trade marine department on the Bristol Channel and, in 1945-46, chairman of the South Wales Branch of the Institution of Mechanical Engineers.

Edward Fitzgerald Moroney was of Irish descent, but was born in Leeds, on July 11, 1874, and received his general education and technical training on Tyneside. After attending St. Cuthbert's grammar school at Newcastle-on-Tyne he was apprenticed in the engineering department of R. and W. Hawthorn, Leslie and Company, Limited, his time being divided, between 1889 and 1895, between their St. Peter's works and the shipyard at Hebburn. After a short period as draughtsman in the office of the works manager, he went to sea as an engineer in the Scottish Shire Line, trading to Australia and New Zealand; in the Welsh Shire Line, to China and Japan; and finally in the Union-Castle Line. During his apprenticeship he had attended evening technical classes at the Railway Institute, Gateshead, and subsequently took the senior course in marine engineering at Armstrong College, Newcastle, which enabled him to qualify, after the requisite seagoing experience, for the Board of Trade Extra First Class Certificate.

On leaving the sea in 1901, he obtained a position as draughtsman with a Dutch engineering firm, the N.V. Machinefabriek Dapoean, at Soerabaya, Java, where he spent some 3½ years on the design, construction and repair of sugar machinery. He then returned to the sea as second engineer, and afterwards chief engineer, of the Cairn Line steamer Cairnglen; but relinquished this appointment in 1905 to go out to Finland as assistant general manager of the shipyard and engine works of William Crichton and Company at Abo and of the associated establishment at Octa, St. Petersburg. Less than a year later, however, he was offered the opportunity to return to Java as works manager; but, a vacancy occurring in the marine department of the Board of Trade for an engineer surveyor, he applied for the appointment and was successful in obtaining it. For the next 20 years, 1906 to 1926, he was stationed in Liverpool and was then transferred to Cardiff as senior surveyor, with survey duties extending into the Midlands and Birmingham, and the responsibility also for conducting, on the Bristol Channel, the periodical examinations of marine engineers for their certificates. The outbreak of war in 1939 caused him to be retained in office beyond the normal retiring age and it was not until the conclusion of hostilities that he relinquished official duties in Cardiff.

Mr. Moroney was a man of many interests of both mind and hand; a designer of merit, with many inventions to his credit, though few of them were patented; when he was living on Merseyside, architect of his own house and constructor, with his own hands, of much of its furniture, including a long-case clock, with solar and lunar dials, of which he was justifiably proud. A self-discharging crewless barge which he designed was adopted to some extent during the war. More recently, he had been interesting himself in simplified methods of ship construction and in the design of houses to be built of prestressed-concrete units. His activity of mind, however, was probably best exemplified by his facility for acquiring foreign languages, for he could converse with reasonable fluency in no fewer than ten, including Chinese, Dutch, Malay, Russian and Swedish. The latest addition to the list, Portuguese, he began to study after his retirement, when nearly 70 years of age. He was the originator, when in Liverpool, of the proposal, subsequently adopted, that the city's Education Committee should set up a municipal training school for marine engineers, and throughout his life consistently urged the importance to an engineer of supporting specialisation with the widest possible general knowledge. If his often unorthodox views on education, economics, patent law and other favourite topics, usually forcibly expressed, did not always receive general acceptance, none could question the sincerity with which they were expressed or the keen sense of the public weal which inspired them.

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MR. C. F. DAVIS

Railway Electrical Engineering

Mr. C. F. Davis, B.A., who died at Winchester on July 6, at the age of 83, spent most of his professional career with the former London and North Western Railway and, after the railway amalgamations of 1923, with the London Midland and Scottish Railway. He retired from the position of chief assistant electrical engineer on the L.M.S. in 1935.

Clement Frederick Davis was educated at Dulwich College, and Trinity College, Cambridge, where he was a Senior Wrangler. His early experience was gained in consulting engineering, with Kennedy and Donkin, in connection with public utility works and with electric traction. He also worked for a time at the (then) Royal Aircraft Factory, Farnborough, on engine development. Shortly before the first World War he joined the L.N.W.R., where he played a prominent part in the electrification of the Euston-Watford line and the construction of the Stonebridge Park power station. In 1930, he worked on the electrification of the Manchester South Junction and Altrincham line – the first 1,500-volt direct-current overhead system in the country. Other large projects with which he was closely connected included the Barking-Upminster electrification, the changeover to 50-cycles supply of the Manchester-Bury lines, the reorganisation of electricity supplies at Crewe works, and the reorganisation of the Formby power station at Liverpool. He was an associate member of the Institution of Civil Engineers and of the Institution of Electrical Engineers.

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PERSONAL

MR. J. C. DUCKWORTH, B.A., chief engineer of the Ferranti Laboratories, Wythenshawe, Manchester, since 1950, has been appointed nuclear power engineer to the British Electricity Authority.

MR. A. R. COOPER, M.I.E.E., M.Inst.F., controller of the North West, Merseyside and North Wales Division, British Electricity Authority, 825, Wilmslow-road, East Didsbury, Manchester, 20, has had conferred upon him the honorary degree of Master of Engineering by the University of Liverpool.

MR. F. H. S. BROWN, B.Sc., M.I.Mech.E., M.I.E.E., deputy generation design engineer at the headquarters of the British Electricity Authority, has been appointed generation design engineer. He succeeds MR. F. SHAKESHAFT, O.B.E., A.M.I.E.E., M.Inst.F., who is to concentrate on future and special generation design problems.

MR. W. B. SHANNON, M.I.C.E., M.I.Mech.E., M.I.E.E., chief generation engineer (construction) of the South Eastern Division, British Electricity Authority, has been appointed chief generation engineer (construction) of the London Division, as from September 1.

MR. W. D. STIVEN, Commodore Engineer, of the Peninsular and Oriental Steel Navigation Co., 122, Leadenhall-street, London, E.C.3, retired on July 12 and has been succeeded in the appointment by MR. W. D. PACEY.

SIR KENNETH GRUBB, C.M.G., formerly controller of overseas publicity at the Ministry of Information, has joined the board of Editorial Services Ltd., 32, Great Queen-street, London, W.C.2, public-relations consultants to the Locomotive Manufacturers' Association of Great Britain.

MR. L. A. M. GINGER, A.M.I.E.E., has been appointed assistant chief electrical engineer, London Transport Executive, 55 Broadway, S.W.1. MR. H. BRANTON, generating-station superintendent, Lots-road, has been appointed assistant electrical engineer (generation) with responsibility for the work in connection with all three of the Executive's power stations, at Lots-road, Neasden and Greenwich.

MR. W. J. MASON, general manager, tube production, Stewarts and Lloyds, Ltd., Glasgow, has been appointed by the Minister of Transport and Civil Aviation, to be a member of the Transport Users Consultative Committee for Scotland.

MR. B. C. LOVATT has been appointed chief engineer of the Southampton works of the Parsons Engineering Co. Ltd., with effect from August 10.

MR. W. G. DUMVILLE, M.C., T.D., has been appointed regional manager, North East, to British Insulated Callender's Cables Ltd., in succession to MR. E. CHARLTON, who is retiring.

DR. H. A. SCARBOROUGH, Principal of Rutherford Technical College, Newcastle-upon-Tyne, since 1939, is to retire. He will be succeeded by MR. J. S. ELLIOTT, at present Principal of Gateshead Technical College.

MR. E. J. NICHOLL, B.Sc. (Eng.), A.F.R.Ae.S., has been elected joint managing director, Dowty Equipment Ltd., Cheltenham, Gloucestershire, in conjunction with MR. G. H. DOWTY, and managing director, Dowty Fuel Systems Ltd. Mr. G. H. Dowty will continue to act as chairman of both companies. MR. F. J. A. MANGEOT has been elected to the board of Dowty Fuel Systems Ltd., and MR. R. C. CUSSONS, D.F.C., M.A. (Cantab.), F.R.Ae.S., has been promoted to become chief designer to Dowty Equipment Ltd.

MR. MAX E. DAVIES, B.A. (Oxon.), who joined the British Iron and Steel Research Association, 11, Park-lane, London, W.1, in 1947, and established its public relations service, is leaving at the end of July to become editor of the *Petroleum Times*. From July 26 Press inquiries should be addressed to MISS I. M. SLADE, M.Sc., information officer.

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BUSINESS CHANGES

MACKAY INDUSTRIAL EQUIPMENT LTD., Faggs-road Feltham, Middlesex, have been appointed distributors of the Pescara-Muntz free-piston compressor produced by ALAN MUNTZ & CO. LTD.

THE DISTILLERS CO. LTD., Devonshire House, Mayfair-place, Piccadilly, London, W.1, and the ORONITE CHEMICAL CO., San Francisco, U.S.A., announce the formation of OROBIS LTD., a jointly-owned company now constructing a plant for the manufacture of lubricating-oil additives at Hull.

Arrangements have been concluded whereby Diesel engines made by F. PERKINS LTD., Queen-street, Peterborough, will be sent to various countries and there fitted into vehicles supplied either by the INTERNATIONAL HARVESTER CO. of Chicago, U.S.A., or the INTERNATIONAL HARVESTER CO. OF AUSTRALIA PTY. LTD., of Dandenong, Victoria, Australia. Furthermore, vehicles fitted with Perkins P6(V) and R6(V) Diesel engines will be supplied by the INTERNATIONAL HARVESTER CO. OF GREAT BRITAIN LTD., LONDON, AND ALSO BY THE INTERNATIONAL HARVESTER CO. (S.A.) PTY. LTD., OF DURBAN, SOUTH AFRICA.

LABORATORY EQUIPMENT

An Important Business Merger

Laboratory work has developed so enormously in recent years to meet the growing requirements of industry, educational establishments and of research organisations, that the provision of laboratory equipment and supplies has become an important business, which is likely to extend rather than to decline in the future. An event which will doubtless have a considerable effect on the progress of this business is the amalgamation of two, or rather three, British firms which have been engaged in it for many years.

The amalgamation, which was announced at a luncheon in London on July 15, is between Griffin and Tatlock, Limited, Kemble-street, London, W.C.2, W. and J. George and Becker, Limited, Hatton Wall, London, E.C.1, and Standley Belcher and Mason, Limited, Birmingham, the last-mentioned firm being a subsidiary company of Griffin and Tatlock. Mr. R. McKinnon Wood, O.B.E., M.A., F.R.Ae.S., chairman of the new company, which will be known as Griffin and George, Limited, presided at the luncheon and proposed the toast of "The Guests." In doing so, he explained that the amalgamation would benefit those whom the business served. The increased size of the organisation, he said, would be helpful in distributing the high overheads and would lead to other economies, notably in the production of catalogues, which were of immense value to customers but were very costly.

Mr. A. J. Philpot, C.B.E., M.A., B.Sc., F.Inst.P., Director of the Scientific Instrument Manufacturers' Association of Great Britain, replied on behalf of the guests. He pointed out that the history of the firms had covered the change from classical laboratory methods to the complex equipment needed in modern times, adding that such firms had played a not unimportant part in the change. They had also been responsible for the export of many British goods and expected to play a greater part in this respect than formerly. The union of two old-established firms in the same business was important. Hitherto, excessive competition had led to unnecessary complications and overlapping, and some degree of amalgamation therefore appeared to be desirable; the existence of other firms, however, would still ensure a good competitive basis in the industry. The spirit of co-operation, he concluded, had been responsible for the amalgamation.

Mr. H. R. Bettinson, M.C., formerly chairman of George and Becker, Limited, and now vice-chairman of the new company, also replied to the toast. He expressed approval of the amalgamation and added that the two concerns were anxious to pool their combined resources for the benefit of their customers.

The registered offices of the new company are at Kemble-street, London, W.C.2. We understand that the two divisions of it will retain their individuality as far as possible for the meantime, but will eventually merge completely. The newly erected offices and warehouses of George and Becker, at Alperton, Middlesex, will become the London headquarters, after extensions, now planned, are completed. The production from the works of Griffin and Tatlock at Mitcham, Surrey, and of George and Becker at Birmingham, will be rationalised and the existing offices in Manchester, Glasgow, Edinburgh and Birmingham will be retained. One of the divisions, with offices in Calcutta, Bombay, and New Delhi, will handle the Indian business, and the representatives in the Commonwealth and foreign countries will remain as hitherto.

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INSTITUTION OF HEATING AND VENTILATING ENGINEERS

Annual Summer Meeting

The recent summer meeting of the Institution of Heating and Ventilating Engineers began on Saturday, July 3, and concluded on the following Tuesday with a banquet and dance. The meeting was held in the Royal Bath Hotel, Bournemouth, and was attended by about 120 members, with their wives and guests. This was the Institution's fourth visit to Bournemouth since the summer meetings began in 1899.

On the first day of the meeting an informal gathering was held. On Monday, an address was given by Dr. W. A. MacFarlane, Director of the National Industrial Fuel Efficiency Service, followed by a paper entitled "Dust Suppression in Foundries" – an abridgement of which was published on page 36 of our July 9 issue – presented by Mr. W. B. Lawrie. Works visits were arranged for the afternoon. On Tuesday an address was given by Mr. W. Thring, M.A., Professor of Fuel Technology, Sheffield University. It was followed by a paper on "The Heating and Ventilating of the Old Bailey," by Miss N. M. Nobbs, M.I.H.V.E.

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THE INSTITUTE OF METALS

Programme of Meeting in Switzerland

The 46th annual autumn meeting of the Institute of Metals will be held in Switzerland. The meeting will open in Zürich on Monday, September 6, and the visitors will leave that city on Saturday, September 11, for Montreux, from which town additional visits to works will be paid until the afternoon of Tuesday, September 14.

On the morning of the first day, Monday, September 6, the visiting members will be welcomed at 9.30 in the Federal Polytechnic High School, after which the 1953 Institute of Metals Platinum Medal will be presented to Dr. G. Masing. The remainder of the morning will be devoted to the joint discussion of two papers dealing with "Grain Refinement." In the afternoon visits will be paid to works in the vicinity of Zürich, and, in the evening, an official reception will be held by the authorities of the Canton and City of Zürich.

The whole of Tuesday, September 7, will be devoted to visits to works in Baden, and Oerlikon and, in the evening, at 8, an official banquet will be held at the Grand Hotel Dolder.

A second technical session will be held on the morning of Wednesday, September 8, at the Federal Polytechnic, when two papers on "The Influence of Extrusion Direction on the Corrosion of Aluminium Alloys," by Mr. E. A. G. Liddiard and Miss W. A. Bell, and "The Staining of Clad Aluminium-Alloy Sheets," by Mr. E. C. Williams and H. J. G. Challis, will be presented and discussed.

In the afternoon, visits will be paid to works in Winterthur.

All-day excursions to works in Schaffhausen and its vicinity have been arranged for Thursday, September 9. In the evening, at 8.30, in the Federal Polytechnic, Professor A. von Zeerleder will deliver the Autumn Lecture, on "Attempts to Improve Aluminium Reduction Since Héroult and Hall."

A third and final technical session will be held at the Federal Polytechnic, at 10.30 a.m., on Friday, September 10. A discussion on "The Constitution of Titanium Alloys," based on eight papers published in the Institute's *Journal* will be held.

The visitors will leave Zürich by special train on the morning of Saturday, September 11, for Montreux. Visits to works at Chippis, Cossonay and Geneva will be paid on Monday, September 13. On the following day, a return will be made to Basle, visiting works at Reconvilier, Dornach, Gerlafingen and Choindez, *en route*.

INSTITUTION OF MINING ENGINEERS DINNER

Appeal for Mining Recruits

At a dinner given by the Institution of Mining Engineers on the occasion of their Summer Meeting, held this year in Sheffield from Wednesday, July 7, to Friday, July 9, emphasis was placed in a number of speeches on the mining industry's urgent need for young recruits. Among the guests at the dinner, which took place on Thursday, July 8, were Sir Hubert Houldsworth, Q.C., D.Sc., LL.D., Chairman of the National Coal Board, and the Lord Mayor of Sheffield, Alderman J. H. Bingham, LL.D., J.P. Major N. E. Webster, O.B.E., M.C., President of the Institution, who spoke of the current failure to attract educated youth to this vital industry, occupied the chair.

In proposing the toast to "The Institution of Mining Engineers," to which Major Webster replied, Mr. W. G. Ibberson, Senior Warden of the Cutlers' Company, mentioned news of improved coal supplies for large-scale users and speculated on the development in the future of such revolutionary mining techniques as underground combustion of coal and extraction by solvents. Major Webster, in replying on behalf of the Institution, considered current progress and the implementation of scientific discoveries. He commented on the introduction of prop-free fronts and the increasing number of machines employed in mines, and referred to two papers read at the Summer Meeting.

In one paper* it had been shown how a reduction of 5s. a ton in the cost of mining coal might be achieved, but this would not necessarily affect the price to the consumer. Another paper† had dealt with mining subsidence, which was proving very costly, and a quarter of a million pounds had recently been paid as restitution for damage caused in this way.

Finally, the President of the Institution appealed to the Press and to the public for support in stimulating recruitment; uninformed criticism was not enough; it was necessary in the national interest to call the attention of youth to the opportunities offered by mining for a diverse and satisfying career. The mining engineer had many responsibilities and, in addition to mining problems, his work included both civil and mechanical engineering and the duties of management. It was therefore essential that adequate numbers of educated young men should continue to enter the industry and the conditions be created to encourage them to do so.

Mr. H. A. Longden, B.Sc., President of the Midland Institute of Mining Engineers, who proposed the toast, "The City and Trade of Sheffield," also spoke of the importance of maintaining the supply of new recruits and said that mining provided a fascinating career with new problems to solve each day of the week, but, unfortunately, few candidates were aware of this. Mr. Longden also reported that the Institution had decided to offer student members wider facilities and the Midland Institute had, for example, invited students to take part in visits made by the senior members. In conclusion, he mentioned the significance of coal to Sheffield, and paid tribute to the progressive spirit of the city. The Lord Mayor of Sheffield replied.

Mr. William Reid, B.Sc., Ph.D., Vice-President of the Institution, proposed the toast of "The Guests." Sir Hubert Houldsworth responded.

* "Machine Mining: Concentration in Space and Time." By A. Scott, B.Sc., and W. M. Noble, B.Eng. (Min.).

† "Recent Research in Mining Subsidence." By C. Beavers and K. Wardell. Both papers presented to Institution of Mining Engineers on July 7, 1954.

AUTOMATIC CONTROL AND COMPUTING

New Division at National Physical Laboratory

A new control mechanism and electronics division has been formed by the amalgamation of the electronics and the control mechanisms sections at the National Physical Laboratory. The officer-in-charge of the Division is Mr. R. H. Tizard, B.A., A.M.I.E.E.

The new division will cover the automatic control of industrial, administrative and experimental operations, as well as the development of techniques and equipment for data processing and computation.

An industrial example of such mechanisms is the automatic control of machines producing precision components in large quantities. Not only are the operations speeded up but personnel can be released from the boredom of repetitive work. It is hoped that this trend will not be confined to the factory floor but that many routine office operations will also be carried out by suitable machines. The new division is represented on a small group formed to study this subject. This group also includes representatives from the organisation and methods division of the Treasury and from the Ministry of National Insurance.

Modern research and development produces innumerable records of events made during tests. The interpretation of such records often takes weeks of skilled work. The new division is developing automatic or semi-automatic equipment to digest this data and produce it in the form of graphs or typescript ready for immediate use.

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THE BRITISH STEEL CASTINGS RESEARCH ASSOCIATION

First Annual General Meeting

Incorporated on March 5, 1953, on which date it assumed full responsibility for all co-operative research within the steel-founding industry, the British Steel Castings Research Association, Broomgrove Lodge, Sheffield, 10, has just held its first annual general meeting. This took place at York on July 13.

The Association has recently been offered, and has accepted, grant-aid from the Department of Scientific and Industrial Research under the Government scheme for giving financial aid to industry to enable research on a co-operative basis to be undertaken. Apart from this source of income, the industry supports the Association to the extent of £40,000 per annum.

As part of its first five-year programme, the Association is to construct, on a site in Sheffield for which negotiations are now proceeding, a fully-equipped foundry experimental station, so that the results of its laboratory researches can be carried forward to a stage of practical development at which they can be applied directly on a production basis in the foundries of member firms.

Following the annual meeting a series of demonstrations, working models and photographs were presented. One of these consisted of a model of a human head which actually breathes and demonstrates the efficiency of a new air-feed mask now being developed on behalf of the British Steel Founders' Association to protect employees from dust. Other demonstrations related to the use of radio-active materials for studying the factors affecting the freezing of steel and the internal soundness of steel castings; a new and rapid non-destructive technique for testing steel castings, based on the use of a scintillation counter; and a swing-frame grinding machine incorporating the Association's patented dust-control device.

Letters to the Editor

GEORGE STEPHENSON'S HOUSE

Preservation of Dial Cottage Assured

SIR, I am sure you will be glad to have the latest news of Dial Cottage, West Moor, where George Stephenson lived from 1805 to 1823, as recalled in ENGINEERING, April 2, page 419, and April 9, page 451.

A builder has purchased Dial Cottage and the adjoining house, Paradise Cottage, and has submitted to the Council a scheme for the division of the latter into two houses, one with two ground-floor rooms, three bedrooms, bathroom and kitchen, etc., and the other with one living room, two bedrooms, kitchenette and bathroom. One member of the firm intends to reside in the larger house. The existing roof is to be stripped, felted and re-tiled, using as far as possible the existing tiles. It has been found possible to connect to the Council's sewer and a new drainage system is to be installed.

The Council have approved of this work to Paradise Cottage and an undertaking has been given by the builder to carry out similar works to Dial Cottage when possession is obtained. The facade is to be preserved with the exception of the lowering of the garden below the floor level.

It is interesting to note that the house, Paradise Cottage, was occupied by Mr. Nicholas Wood, who was colliery viewer at the same time that George Stephenson was engineer at the Killingworth Colliery. You will, no doubt, have records of Mr. Wood as he was a founder of the Institution of Mining Engineers and, I understand, had collaborated with George Stephenson in building the Blucher and subsequent Killingworth engines and was associated with him in his invention of the miner's safety lamp. I understand that he wrote three books on the work of George Stephenson.

I feel now that the houses are to be put into a satisfactory condition and will be so maintained for a considerable number of years.

Yours faithfully,
W. N. LOCKEY,
Senior Sanitary Inspector.

Longbenton Urban District Council,
Forest Hall,
Newcastle-upon-Tyne, 12.
July 1, 1954.

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HEAT CAPACITY OF LAMINATIONS

Contribution of the Insulation

SIR, We were glad to read the letter from Dr. E. Marks concerning our short note entitled "Heat Capacity of Laminations" published in your issue of June 18, 1954.

Although Dr. Marks points out that hot-rolled transformer sheets are nowadays supplied free from oxide, much material has undoubtedly been supplied not in that form. We had understood (though not from Dr. Marks' firm) that the constitution of the oxide scale is thought to be mainly Fe_2O_3, and naturally we were not unaware that there may also be inter-laminar insulation such as kaolin, shellac or other varnish or thin paper. In our note, which was abbreviated for publication, discussion of the nature of the layers was subordinated to the general question of their heat capacity. Despite the fact that the temperature rise of a laminated core during a short period of time will probably depend largely upon this thermal property, manufacturers have not been able to provide figures for effective specific heats nor for the other thermal properties of their laminations, however treated and coated. It would be interesting to know whether Dr. Marks could now produce heat-capacity figures for various standard grades of his firm's magnetic steel laminations. We should add that we have given much thought to the thermal effects of certain insulating coatings and that they will add considerably to the effective specific heat or heat capacity of laminations even when applied in a very thin layer. Their effect upon heat conductivity through the pack of lamination will be even more marked. The comments made by Dr. Marks are appreciated and we should be glad of any further information upon this subject which he may have available.

Yours faithfully,
L. G. A. SIMS.
K. L. MORPHEW.

Electrical Engineering Department,
The University of Southampton.

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I.E.E. "PROCEEDINGS"

Revised Publications Arrangements

One of the principal objects of a professional engineering institution is to provide its members with information. The attainment of this object is, however, beset with two difficulties, especially in the case of the larger bodies. One of these is economic, since progress has the result of increasing the number of communications and thus leads to an even higher printing bill. Moreover, a great deal of what is published is, in this age of specialisation, only of interest to a proportion of the members so that its "efficiency" tends to be low.

In 1949, the Institution of Electrical Engineers tackled this dual problem by dividing its *Proceedings* into three parts – General, Power Engineering and Radio Engineering – and instituting a *Journal* containing news items and digests of certain of the papers appearing in Part I. More recently, papers of interest only to a minority of the members have been first published as separate monographs and then in a fourth part of the *Proceedings*. "Rationing by purse" was also instituted to some extent.

This division of material was obviously a little arbitrary in that all the papers read before the Measurements Section were published in the part of the *Proceedings* dealing with power engineering, although some of them may have been of greater interest to radio engineers. Moreover, all papers read at ordinary meetings, as distinct from sectional meetings, appeared in the General part. It has now therefore been decided that the content of a paper and not the meeting at which it was read shall determine the part of the *Proceedings* in which it is to be published. Further, the *Proceedings* will be divided into three parts only, covering power engineering, radio and electronic engineering and monographs, respectively. The first two parts will be published in alternate months and the third twice a year.

In addition, a new publication, to be known as the *Journal of the Institution of Electrical Engineers*, will be issued monthly. This will be a less formal publication than its predecessor and, in addition to items of general interest, will contain special articles on current papers or events, as well as, periodically, an engineering review of wider appeal than the present progress reports. Correspondence will also be included.

Although full details of the new arrangement are not yet available, it is intended that the *Journal* shall be a model of typography and lay-out. As these are subjects in which, as recent events have shown, ENGINEERING also takes an interest, we look forward to the first issue with some eagerness, and hope also that the changes will assist members in the difficult task of keeping abreast of recent developments.

BOOK REVIEWS

Deep Drawing. By J. WILLIS. *Butterworths Scientific Publications*, 88 *Kingsway, London, W.C.2.* (25*s.*)

Until comparatively recently the results obtained in drawing and pressing sheet metal into the forms required for its numerous applications have depended mainly upon the practical knowledge and experience of highly skilled craftsmen. Skill and experience are still essential to-day but, largely due to the great requirements of the motor-car manufacturing industry, it was considered necessary some few years ago to study the underlying principles upon which the art is based. Accordingly, some 17 years ago, a committee of the Institution of Automobile Engineers invited Professor H. W. Swift, of Sheffield University, to investigate the engineering aspects of deep drawing and this work, afterwards carried on under the auspices of the Motor Industry Research Association and now sponsored by the British Iron and Steel Research Association, has resulted in the acquisition and dissemination of a great deal of valuable theoretical and practical knowledge of the subject.

Although most of Professor Swift's work has been published in the form of reports or contributions to the appropriate technical institutions, it was felt that the results were not widely known to or utilised by the practical men in the sheet-metal industry whom it was intended to help. A committee of the two above-mentioned Research Associations, and of the British Non-Ferrous Metals Research Association, therefore decided that the substance of the work should be published in book form for the greater convenience of a wider public. Through the good offices of Dr. J. D. Jevons, who was Messrs. Joseph Lucas's representative on the Committee, Mr. J. Willis, formerly of the firm's research staff, was entrusted with the task of reviewing Professor Swift's researches and preparing the substance of them for publication. That is the *raison d'être* of the book which has now appeared, as explained in a foreword by Mr. J. T. Scott, Chairman of the Sheet Metal Working Committee of the British Iron and Steel Research Association.

The book first illustrates and describes the experimental equipment employed, most of which was specially designed for the purpose by Professor Swift. The next chapter is devoted to the development of a theory of deep drawing and the two following chapters deal with the drawing of cylindrical cups in one or two stages, tool design being considered in this connection. The operation known as " ironing " is commonly employed in industry, its object being to control the maximum external diameter and wall thickness of a drawn cup or to prevent wrinkling at the rim. For this purpose, the walls of the cup are forced through dies having a restricted clearance, the ultimate thickness of the wall being nominally equal to this clearance. The fifth chapter of the book deals with the technique of this operation and explains the investigations made to solve the problems involved. Subsequent chapters cover the work done on shearing bars and blanks, deep-drawing lubricants, the effects of sheet temper and punch profile, and the test methods employed for assessing the deep-drawing properties of materials.

In a brief concluding chapter the author has summarised the practical results of the whole of the research work reviewed in the book, and the application of these results to the design and use of the press tools employed in industry should enable the best performance to be obtained from them. Each chapter commences with a summary of its contents and concludes with references to those reports from which further information can be obtained – a circumstance which will doubtless be appreciated by readers. They would also, perhaps, find a subject-matter index convenient for casual reference, although the book is obviously more suitable for careful study than for use as a work of reference. Throughout it emphasises the practical aspects of Professor Swift's researches and will thus make a direct appeal to men engaged in the deep-drawing industry, the importance of which needs no emphasis.

The Home Workshop. Planning, Wiring, Selection and Maintenance of Power and Hand Tools. By WILLIAM R. WELLMAN. *D. Van Nostrand Company, Incorporated*, 250 *Fourth-avenue, New York* 3, *N.Y., U.S.A.*; and *Macmillan and Company, Limited, St. Martin's-street, London, W.C.*2. (27*s.*)

Those who possess a small home workshop and use it as a hobby range from amateurs to skilled craftsmen, but probably all classes will find something of interest and value in this book. It is in the main concerned with woodworking and many engineers will be likely to spend their spare time on some form of metal-working. They may, however, find it necessary, on occasion, to employ wood construction in place of metal, owing to lack of facilities for dealing with the latter. It is hardly likely that the average home workshop will contain the lathe, bandsaw, circular-saw, drill press, grinder, jig saw, wood-planer and workbench, which Mr. Wellman specifies for his " ideal " workshop; the home worker, however, can utilise the information relating to the particular types of machine which he has been able to acquire.

The book deals with the layout and arrangement of a workshop, lighting and power arrangements, and the selection of machines and tools. It is assumed that an electric power supply is available and instructions are given about wiring. The insistence that ordinary twin flex should not be used will be unreservedly approved, but the same thing cannot be said about the arrangement proposed to prevent children or other unauthorised persons from operating the machines. It is suggested that a length of flexible cable incorporating a switch and fitted with a plug, and long enough to reach to any motor, should be used to connect any machine to the power supply. When not in use, the cable should be " locked in a safe place." Instead of having this cable straggling about the shop floor, the obvious way to prevent interference is to arrange permanent connections to the motors and mount the main switch in a cabinet with a lock.

The book contains useful information about the sharpening and care of tools. Many amateurs will find the instructions for grinding twist drills particularly valuable. Mention may also be made of an easily-constructed jig for accurately setting saw teeth.

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TRADE PUBLICATIONS

Electric Motors in Handling Equipment. A leaflet published by Lancashire Dynamo & Crypto Ltd., St. Stephen's House, Victoria-embankment, London, S.W.1, shows examples of electric motors used in mechanical-handling equipment.

Cartridge Fuses. A. Reyrolle & Co. Ltd., Hebburn, Co. Durham, have issued a revised edition of their list of Class G.P. cartridge fuse-links. Descriptions and dimensions are given for capacities up to 600 amperes.

Feeder-Protection. Particulars of the Solkor-B type of feeder protection are given in a revised leaflet published by A. Reyrolle & Co. Ltd., Hebburn, Co. Durham.

Electric Motors for Experimental Work. A leaflet published by A. Reyrolle & Co. Ltd., Hebburn, Co. Durham, describes a range of variable-speed alternating-current commutator motors, specially designed for experimental and demonstration work in schools and colleges.

Laboratory Potentiometer. The Croydon Precision Instrument Co. 116 Windmill-road, Croydon, Surrey, have published a leaflet on a self-contained direct-current potentiometer, a medium-grade instrument with built-in reflecting galvanometer and batteries. The overall range is from 1·9 volts to 5 microvolts.

Condenser Tubes. The Metals Division of Imperial Chemical Industries Ltd., Imperial Chemical House, Millbank, London, S.W.1, have published a booklet dealing with non-ferrous condenser tubes for steam-condensing plant. The range of alloys available is mentioned, the various forms of attack to which they are subject are discussed and methods of protection in service are indicated. Illustrations of different types of corrosion are included and the booklet concludes with tables of tube weights and other data.

Optical Instruments. The catalogue of the Hilger Division of Hilger & Watts Ltd., 98 St. Pancras-way, Camden-road, London, N.W.1, is being reprinted and two sections, those dealing with monochromators and spectrometers (section D), and with refractometers, polarimeters, strain-viewers and similar apparatus (section M) have now been issued.

Infra-Red Spectrophotometer. A brochure published by Hilger & Watts Ltd., 98 St. Pancras-way, Camden-road, London, N.W.1, describes their recording infra-red spectrophotometer, type H.800. Full constructional and operational details are given and sample recordings of different materials reproduced.

Plastics in the Cable Industry. An illustrated booklet published by the Telegraph Construction and Maintenance Co., Ltd., Telcon Works, Greenwich, London, S.E.10, describes the applications of plastics in the cable industry. The properties of the various plastics are explained and the types of cable available described.

Selenium Rectifiers. The Hackbridge and Hewittic Electric Co., Ltd., Walton-on-Thames, Surrey, have issued a leaflet describing their selenium rectifier equipments. Some of these have outputs of 1,500 amperes.

Radio Valves and Cathode-Ray Tubes. Ferranti Ltd., Hollinwood, Lancashire, have issued revised data sheets relating to their range of radio-valves and cathode-ray tubes.

Polarograph. Evershed and Vignoles Ltd., Acton-lane Works, Chiswick, London, W.4, have published a leaflet giving details of a Tinsley Polarograph added to their range – the " Minor." This is a direct-reading model with a derivative circuit, having 16 ranges and a maximum sensitivity of 0·02 micro-ampere for full-scale deflection.

* * *

BOOKS RECEIVED

Tables of Integral Transforms, Volume I. Based, in part, on notes left by HARRY BATEMAN. Compiled by the Staff of the Bateman Manuscript Project. *McGraw-Hill Book Company, Incorporated*, 330 *West* 42*nd-street, New York* 36, *N.Y., U.S.A.* (7·50 dols.); and *McGraw-Hill Publishing Company, Limited*, 95 *Farringdon-street, London, E.C.*4. (60*s.*)

Guide to the Coalfields, 1954. Edited by R. H. WALKERDINE. *The Colliery Guardian Company, Limited*, 30 *and* 31 *Furnival-street, Holborn, London, E.C.*4. (20*s.*)

Engineering for Agricultural Drainage. By Professors HARRY BURGESS ROE and QUINCY CLAUDE AYRES. *McGraw-Hill Book Company, Incorporated*, 330 *West* 42*nd-street, New York* 36, *N.Y., U.S.A.* (7·50 dols.); and *McGraw-Hill Publishing Company, Limited*, 95 *Farringdon-street, London, E.C.*4. (60*s.*)

Drawing, Sketching and Blueprint Reading. By SHRIVER L. COOVER. Edited by Professor CHRIS H. GRONEMAN. *McGraw-Hill Book Company, Incorporated*, 330 *West* 42*nd-street, New York* 36, *N.Y., U.S.A.*; and *McGraw-Hill Publishing Company, Limited*, 95 *Farringdon-street, London*, E.C.4. (32*s.*)

CABMA Register of British Products and Canadian Distributors, 1954-55. Published for the Canadian Association of British Manufacturers and Agencies, jointly by *Kelly's Directories, Limited*, 186 *Strand, London, W.C.*2; and *Iliffe and Sons, Limited, Dorset House, Stamford-street, London, S.E.*1. (42*s.*)

Statistical Year-Book of the World Power Conference. No. 7: Annual Statistics for 1950-1952. Edited by FREDERICK BROWN. Published on behalf of the Central Office of the World Power Conference, by *Lund Humphries and Company, Limited*, 12 *Bedford-square, London, W.C.*1. (40*s.*)

Deep Drawing. A Review of the Practical Aspects of Professor H. W. Swift's Researches. By J. WILLIS. *Butterworth's Scientific Publications*, 88 *Kingsway, London, W.C.*2. (25*s.*) (Reviewed on this page.)

Forest Products Research, 1953. Published for the Department of Scientific and Industrial Research by *H.M. Stationery Office, Kingsway, London, W.C.*2. (3*s.*)

Zahnräder. Band I: Stirn-und Kegelräder mit geraden Zähnen. By Dr.-Ing. W. LINDNER. *Springer-Verlag, Reichpietschufer* 20, *Berlin W.*35. (18 *D.M.*)

AN IMPROVED LANOVA-TYPE OIL ENGINE

COMPARISONS WITH PERFORMANCE OF TWENTY YEARS AGO

By Professor S. J. Davies, D.SC. (ENG.), PH.D., M.I.MECH.E.

The progress made during the past 25 years or so with the compression-ignition oil engine has been in the direction of obtaining the best possible practical compromise between the highest brake mean effective pressures and thermal efficiencies, on the one hand, and the need for reliability in service on the other. The question of reliability is bound up with the order of the loading on the pistons and running gear and with the steady improvements made in the material and design of the parts under consideration. The mechanical loading is principally composed of two elements, namely, the value of the maximum pressures in the cylinders to be accepted or tolerated, and the rate of rise of pressure acting on the piston during the combustion process; the latter is usually of greater importance than the former. The thermal loading on the piston and valves is a further important matter. A type of combustion chamber in the design of which special consideration has been given to the loading is the Lanova, which belongs to the group characterised by the use of an auxiliary chamber,* the function of which is to control favourably the variations in the pressure and temperature loading on the piston.

At the invitation of the Lanova, G.m.b.H., 41 Laimerstrasse, Munich, the author investigated, nearly 20 years ago, the characteristics and performances of two oil engines of that company's design.† Tests showed that the loading on the pistons was extremely low, but that the highest values of the brake mean effective pressure and brake thermal efficiency were lower than those given by many engines at that time. The last two factors were deemed of special importance in Great Britain; in the United States of America, in comparison, the principal emphasis was placed on the reduced maintenance expenses associated with the low piston loading, and several important engine builders in that country embodied the Lanova design.

In the present report, the further evolution of the design will be considered in the light of the results of tests carried out recently at Munich by the author, and it may at once be said that the brake mean effective pressure and the brake specific fuel consumption now reach very satisfactory values, while the piston loading, although somewhat higher than was formerly the case, still possesses the desirable characteristics of a low maximum pressure and a low rate of rise of pressure. The thermal loading on the pistons and exhaust valves is also much lower than that in many contemporary engines. The changes in the form of the combustion chamber will first be described and some consideration will be given to the manner in which the combustion processes develop; next, the results of engine tests will be set out and discussed; thirdly, the processes of combustion will be further considered in relation to the indicator diagrams taken from both the main and the auxiliary chambers, and lastly, general conclusions will be drawn concerning the design.

CHANGES IN COMBUSTION CHAMBER

The earlier construction is recalled by the reproduction, in Figs. 1 and 2, of the figures in the earlier report. In this construction, the shape of the main chamber in plan ranged, according to the dimensions and fields of application of particular engines, from the rough figure eight shown to something approaching a heart. The new construction is shown in Fig. 3, and, in developing this form from the earlier one, two basic changes were considered to be desirable, namely, a reduction in the heat losses to the walls and an increase in the compression ratio from 12·5 : 1 to approximately 15 : 1, both of which lead to a reduction in the ignition lag following the beginning of the injection. In a comparison of the new form with the earlier one, the following points may be mentioned: the main chamber has been changed in form and reduced in volume; owing to the reduction in volume of the main chamber, the admission valve is now outside the main chamber; the auxiliary chamber remains in two parts but, with the higher compression ratio, the starting valve is no longer necessary to ensure starting. The exhaust valve remains in the main chamber and forms part of the walls, which are at a sufficiently high temperature. While the exhaust valve is thus restricted as regards its dimensions, the admission valve can be made larger, a factor leading to good volumetric efficiency.

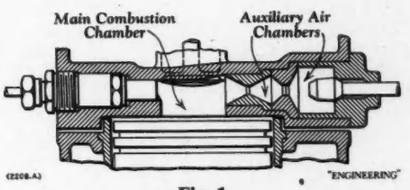

Fig. 1

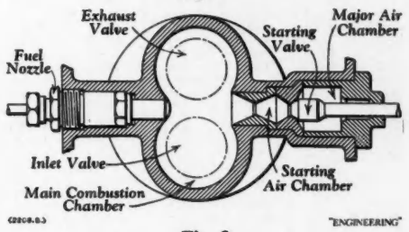

Fig. 2

Figs. 1 and 2 The cylinder head in earlier versions of the Lanova oil engine. Fig. 1 shows valve position when running, Fig. 2 when starting.

COMBUSTION PROCESSES

As a result of the considerable study of the combustion processes that has accompanied the changes in the design, the following explanation of these processes is now accepted. The auxiliary chamber in its latest form is regarded as the space in which energy is stored rather than as a source of supplementary air; as the figure shows, it still has two constrictions, the second providing the passage into the main chamber. Both the main and the auxiliary chambers are in the cylinder head, and their cooling can be arranged as desired; in particular, the highest temperatures can be confined to the auxiliary chamber. An advantage is that the piston head is plane. The main chamber is open towards the volume swept by the piston, so that the gas velocities from chamber to cylinder are small, with low fluid friction losses. Only a relatively small proportion of the gases enter the auxiliary chamber or "energy reservoir," and the throttling losses that result from the movement of these gases into and out of the chamber are correspondingly low.

The mixing of the fuel with the combustion air follows mainly from the processes in the auxiliary chamber and, as a result, it is possible to use a fuel nozzle of pintle form; this form of nozzle keeps itself free from deposit and gives reliable operation of the engine. The jet from the nozzle has a small angle of divergence and the fuel is injected across the main chamber towards the mouth of the auxiliary chamber. A part only of the fuel enters the auxiliary chamber, but this burns in the inner part very rapidly and with a very high rate of rise of pressure. This rise of pressure in the auxiliary chamber takes place earlier than that in the main chamber, and is helped by the high temperature at which the auxiliary chamber is kept, since the cooling of this part is limited. The energy for the mixing of the fuel particles with the air for combustion in the main chamber is developed in the auxiliary chamber, which, as indicated above, is regarded as a reservoir of energy.

As a result of the high pressures rapidly developed in the auxiliary or energy chamber, the burning gases there are forced out at high velocity into the main chamber. The interval of time from the beginning of injection from the nozzle until the ejection of the gases from the energy chamber into the main chamber is sufficiently long for the particles of fuel which remain in the main chamber to be vaporised; in fact, by this time, some of these particles of fuel will already have become ignited. The gases flowing out of the energy chamber arrive, therefore, at such an instant that they play a vital part in accelerating and completing the combustion in the main chamber of the fuel particles there which have passed through the essential preliminary stages of ignition. As a result of the good preparation of this fuel and

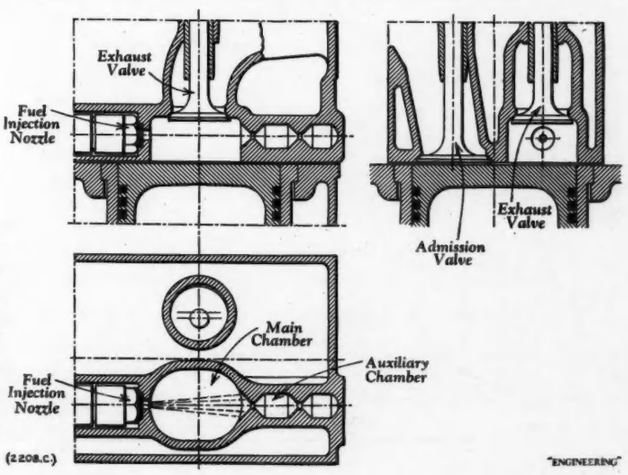

Fig. 3 Construction of combustion chamber in the new Lanova oil engine with higher compression ratio (now 15:1), the admission valve outside the chamber, and no starting valve.

* See a classification of combustion chambers by the author: *Proc. I. Mech. E.*, vol. 122, page 685 (1932).

† ENGINEERING, vol. 138, pages 599 and 660 (1934).

TABLE I.

Test No.	R.p.m.	B.M.E.P., lb. per sq. in.	B.h.p.	Fuel, lb. per hr.	Fuel, lb. per b.h.p. per hr.	Test No.	R.p.m.	B.M.E.P., lb. per sq. in.	B.h.p.	Fuel, lb. per hr.	Fuel lb. per b.h.p. per hr.
A1	1,042	7·6	5·2	5·48	1·046	D1	1,768	12·3	14·3	12·97	0·908
A2	1,018	20·5	13·8	8·19	0·595	D2	1,746	26·2	30·1	17·48	0·581
A3	1,002	38·4	25·4	11·75	0·463	D3	1,746	39·2	45·1	22·30	0·495
A4	1,016	55·4	37·1	15·32	0·413	D4	1,761	50·8	58·9	26·08	0·444
A5	1,006	62·6	41·5	16·97	0·409	D5	1,749	57·6	65·8	28·30	0·430
A6	999	70·4	46·3	18·34	0·396	D6	1,750	66·0	76·1	31·60	0·415
A7	1,016	78·9	52·7	20·65	0·392	D7	1,754	76·1	87·9	35·53	0·405
A8	1,019	88·0	59·1	22·97	0·390	D8	1,758	81·9	94·9	38·25	0·403
A9	1,004	94·8	62·7	23·91	0·381	D9	1,756	88·0	101·8	41·07	0·403
A10	993	100·8	65·8	25·08	0·381	D10	1,762	95·6	110·8	44·40	0·401
A11	1,012	109·7	73·1	27·82	0·381	D11	1,750	110·7	127·7	52·37	0·410
A12	1,017	121·5	81·4	32·37	0·398	D12	1,746	116·9	134·7	56·60	0·421
B1	1,260	7·8	6·5	7·20	1·117	E1	1,982	9·1	11·9	13·86	1·163
B2	1,257	18·3	15·1	9·90	0·655	E2	2,000	21·4	28·2	18·56	0·660
B3	1,253	37·2	30·7	14·54	0·473	E3	1,987	32·4	42·5	23·14	0·545
B4	1,259	53·2	44·1	18·61	0·422	E4	2,013	40·5	53·8	26·90	0·500
B5	1,253	62·4	51·6	21·20	0·411	E5	2,000	48·1	63·3	29·45	0·465
B6	1,254	70·0	57·8	23·15	0·401	E6	1,991	55·3	72·7	32·70	0·450
B7	1,245	77·1	63·2	25·00	0·396	E7	1,996	65·4	86·0	37·14	0·432
B8	1,260	85·3	70·8	28·08	0·397	E8	1,988	72·1	94·5	39·38	0·416
B9	1,243	91·8	75·2	29·90	0·397	E9	1,987	78·5	102·7	42·38	0·413
B10	1,253	100·0	82·5	32·13	0·389	E10	1,989	86·0	112·8	46·93	0·416
B11	1,251	108·1	89·2	34·95	0·392	E11	1,996	102·4	134·5	56·15	0·417
B12	1,260	120·0	99·6	41·10	0·412	E12	1,989	110·2	144·3	60·80	0·421
B13	1,248	121·2	99·8	41·85	0·420						
C1	1,510	7·5	7·5	8·93	1·201	F1	2,289	7·8	11·7	17·02	1·452
C2	1,492	15·6	15·3	11·30	0·739	F2	2,287	15·6	23·5	19·57	0·834
C3	1,503	32·1	31·4	15·94	0·508	F3	2,283	23·6	34·7	23;62	0·681
C4	1,497	46·9	46·3	20·80	0·449	F4	2,282	31·1	46·8	27·38	0·582
C5	1,496	56·5	55·6	23·62	0·425	F5	2,282	39·1	58·2	31·00	0·531
C6	1,493	63·7	62·7	26·05	0·416	F6	2,283	46·2	69·5	34·40	0·495
C7	1,496	73·9	71·9	29·10	0·405	F7	2,283	53·3	80·4	38·25	0·476
C8	1,502	81·8	80·9	32·22	0·398	F8	2,280	60·7	91·3	42·14	0·461
C9	1,494	87·4	86·0	34·42	0·400	F9	2,280	68·4	102·7	45·76	0·445
C10	1,494	94·7	93·2	36·50	0·392	F10	2,282	76·1	114·3	49·80	0·435
C11	1,488	102·4	100·3	39·82	0·397	F11	2,296	82·9	125·2	54·75	0·437
C12	1,496	117·0	115·4	47·62	0·412	F12	2,295	90·8	137·4	59·72	0·435
C13	1,527	122·0	122·8	51·70	0·421	F13	2,293	97·7	147·6	66·00	0·448

the intimate degree of mixing brought about by the violent turbulence, the time necessary for combustion is considerably shortened, a basic condition for high thermal efficiency. The division of the complete combustion process into the preliminary stage in the energy chamber followed by the principal stage in the main chamber leads to reduced ignition noise and a smoother running of the engine. As stated above, further consideration will be given to the processes of combustion after the tests have been described.

DESCRIPTION OF ENGINE

The six-cylinder engine under test was built by Henschel and Sohn, G.m.b.H., of Cassel, and is a direct descendant of the six-cylinder engine of which the tests were described in the earlier report. It is designated as Type 513 DC, and its nominal output is 140 PS, that is, 138 h.p. The cylinder bore is 110 mm. (4·33 in.) and the piston stroke is 150 mm. (5·91 in.), giving a total swept volume of 8·6 litres. The bore thus remains the same but the stroke is now shorter by 10 mm. (0·39 in.). The general technical improvements made in the interval have been embodied in the design, and the engine, thousands of which are in service, is a well-tried unit following conventional lines. The engine body and the cylinders are in one piece but each cylinder head is separate; the cylinder liners are removable and are in direct contact on their outer surfaces with the cooling water. Accessibility to all auxiliaries is good and leads to easy maintenance. The injection pumps and nozzles are supplied by Robert Bosch, G.m.b.H.

BASIC TESTS

In the basic tests the engine was run at a series of roughly constant brake torques, and the speeds were varied so as to give a series at each of the following values: 1,000, 1,250, 1,500, 1,750, 2,000, and 2,300 r.p.m., the loads at each speed covering the range from light to full. The principal data from these tests are tabulated in Table I, and are derived from readings of the brake torque, the revolutions per minute, and the fuel consumption. The power developed by the engine was absorbed and measured by means of a hydraulic dynamometer. This was afterwards uncoupled from the engine, its zero balance and its dimensions were checked, the spring balance was calibrated, and the readings found to be without appreciable error. In the table the brake torques have been converted into the equivalent values of B.M.E.P. While a tachometer afforded a continuous check on the constancy of the speed of the engine, the actual values of the r.p.m. were measured by means of a counter and a stop watch. The rates of fuel consumption were observed by noting the times to consume suitable measured quantities; these quantities were taken from vessels which were afterwards calibrated. The small quantities of leakage oil were neglected.

The fuel used in the basic tests was a gas oil. It was submitted for test at the Technische Hochschule, Munich, and the following data are extracted from the reports of Professor Kneule and Professor Loschge: specific gravity, 0·835 at 59 deg. F. (15 deg. C.); higher calorific value, 19,611 B.Th.U. per lb. (10,895 kcal. per kg.); lower calorific value, 18,311 B.Th.U. per lb. (10,173 kcal. per kg.); carbon content, 86·8 per cent.; hydrogen content, 12·9 per cent.; cetane number, from engine test, 57·4, and, as calculated, 65. Mean distillation temperature, 532 deg. F. (277·8 deg. C.).

The cooling water was circulated through the system at roughly constant temperatures, and the rate of flow was adjusted so that the water, with a rise of temperature ranging up to 22 deg. F. (12 deg. C.), always left the engine at about 180 deg. F. (82 deg. C.). The room temperature varied during the tests from 64 to 75 deg. F. (18 to 24 deg. C.). The barometer stood at the low value of 28·3 in. (718 mm.) of mercury, corresponding to the considerable altitude of Munich.

The data of Table I were first plotted as brake specific fuel consumption on a base of B.M.E.P. The curves are given in Fig. 4 and attention may be drawn to the open scale of the ordinates. The curves show that at all speeds up to and including 2,000 r.p.m. the values of B.M.E.P. reach at least 110 lb. per square inch. These are good values when the low barometric pressure is taken into account. In this range of speeds, too, the brake specific consumptions at values of the B.M.E.P. from 70 to 110 lb. per square inch do not exceed 0·42 lb. per brake horse-power per hour and are mostly well below this value; the lowest values are about 0·38 lb. per brake horse-power per hour. The values of the "limit of satisfactory exhaust" given in Fig. 4, and later in Fig. 9, were derived from the values plotted in Fig. 10 and obtained by the method described separately later in this report. Consideration of the curves in Fig. 4 also shows that the torques are greatest at the lower speeds,

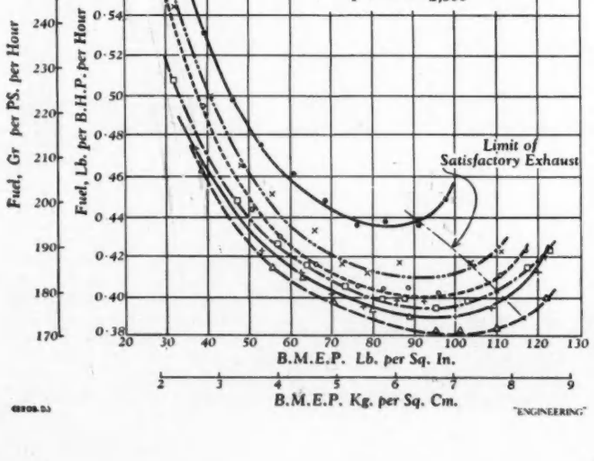
Series A 1,000 R.P.M.
" B 1,250 "
" C 1,500 "
" D 1,750 "
" E 2,000 "
" F 2,300 "
Limit of Satisfactory Exhaust
Fuel, Gr per PS. per Hour
Fuel, Lb. per B.H.P. per Hour
B.M.E.P. Lb. per Sq. In.
B.M.E.P. Kg. per Sq. Cm.
"ENGINEERING"

Fig. 4 Specific fuel consumption and brake mean-effective pressure at different speeds.

TABLE II.

Series	A	B	C	D	E	F
R.p.m.	1,000	1,250	1,500	1,750	2,000	2,300
F.M.E.P., lb. per sq. in.	19·1	20·9	22·2	23·5	24·9	26·3
Test 1 ..	26·7	28·7	29·7	35·8	34·0	34·1
" 2 ..	39·6	39·2	37·8	49·7	46·3	41·9
" 3 ..	57·5	58·1	54·3	62·7	57·3	49·9
" 4 ..	74·5	74·1	69·1	74·3	65·4	57·4
" 5 ..	81·7	83·3	78·7	81·0	73·0	65·4
" 6 ..	89·5	90·9	85·9	89·5	80·2	72·5
" 7 ..	98·0	98·0	95·1	99·6	90·3	79·6
" 8 ..	107·1	106·2	102·0	105·4	97·0	87·0
" 9 ..	113·9	112·7	109·6	111·5	103·4	94·7
" 10 ..	119·9	120·9	116·9	119·1	110·9	102·4
" 11 ..	128·8	129·0	124·6	134·2	127·3	109·2
" 12 ..	140·6	140·9	139·2	140·4	135·1	117·1
" 13 ..	—	142·1	144·2	—	—	124·0

TABLE III.

Test No.	R.p.m.	B.M.E.P., lb. per sq. in.	I.M.E.P., lb. per sq. in.	Brake spec. consumpt. lb. per b.h.p. per hr.	Ind. spec. consumpt. lb. per i.h.p. per hr.
A9	1,000	94·8	113·9	0·381	0·313
B7	1,250	77·1	98·0	0·396	0·312
C6	1,500	63·7	85·9	0·416	0·309
D6	1,750	66·0	89·5	0·415	0·306
E6	2,000	72·1	97·0	0·416	0·309
F7	2,300	53·3	79·6	0·476	0·318

a desirable point in the design of an engine for use in transport.

DETERMINATION OF MECHANICAL LOSSES

In considering the Lanova design in relation to its combustion conditions, however, the indicated rather than the brake performance is more important. In order to obtain information concerning the mechanical losses, and so to deduce the values of the indicated M.E.P., the hourly fuel consumptions of the engine for the six series, A to F, were plotted on a base of M.E.P. The curves so obtained are given in Fig. 5 and take the form usual in compression-ignition engines, namely, they are straight lines from light loads upwards until, with increasing fuel charges, the curves diverge upwards as the combustion deteriorates towards the higher loads. If the straight lines are extrapolated downwards to cut the base line, the values of the F.M.E.P. shown for the six series are obtained. The points from the test observations are seen to lie well on the straight lines; further, when the values of F.M.E.P. were plotted on a base of revolutions per minute, they fell, within the range from 1,000 to 2,300 r.p.m., practically on a straight line: F.M.E.P. = 13·7+0·00544 (r.p.m.) in lb. per square inch. This fact has no particular significance, except that it provides additional evidence that the values of F.M.E.P. were as accurate as could be expected with this method.

FUEL CONSUMPTION AND EFFICIENCY

Assuming the value of F.M.E.P. obtained for any series to apply to all loads of the series, the corresponding values of I.M.E.P. may be found; they are tabulated for the six series in Table II. If the straight-line portions of the curves in Fig. 5 are considered, it is found that the values of fuel consumption per hour are in direct proportion to the values of I.M.E.P., and they are, therefore, lines of constant indicated thermal efficiency. For each series, a test point that lies directly on the corresponding straight line was taken; for this test, the values of B.M.E.P. and fuel consumption in lb. per brake horse-power-hour were extracted from Table I and the value of the I.M.E.P. from Table II. These values are tabulated in Table III, and from them the values of the indicated consumption in lb. per indicated horse-power hour given in the last column are calculated. It is seen that all values fall within the range from 0·306 to 0·318, that is, within 2 per cent. of the mean value, 0·312. Inspection of Fig. 5 and Table I shows that this is tantamount to saying that, over the speed range from 1,000 to 2,300 r.p.m. and for outputs from zero to about 100 brake horse-power, the thermal efficiency of the combustion process, referred to the higher calorific value of the fuel, is practically constant at 41·6 per cent. This is important evidence of the wide flexibility as regards load and speed of the combustion system of this engine.

If, taking the extrapolated values of F.M.E.P. into account, the mechanical efficiency of the engine at speeds from 1,000 to 2,000 r.p.m. is considered, a B.M.E.P. of 110 lb. per square inch may be taken as a reasonable value for comparison. It is found that the percentage values of mechanical efficiency at this B.M.E.P. range from 85·2 at the lowest speed to 81·6 at 2,000 r.p.m., and are normal for this type of engine.

PRESSURE LOADING ON PISTONS

As in the earlier report,* special attention was given to the measurement of the pressures in the main chamber and in the energy chamber. The former is, of course, of vital importance, since the special advantage claimed for the Lanova system is the lower pressure loading on the pistons and running gear of the engine. Attempts were made to obtain reliable indicator diagrams with the aid of a cathode-ray indicator, but the author was not satisfied concerning the accuracy to be obtained by this means. This indicator embodied a quartz element in which

* Loc. cit.

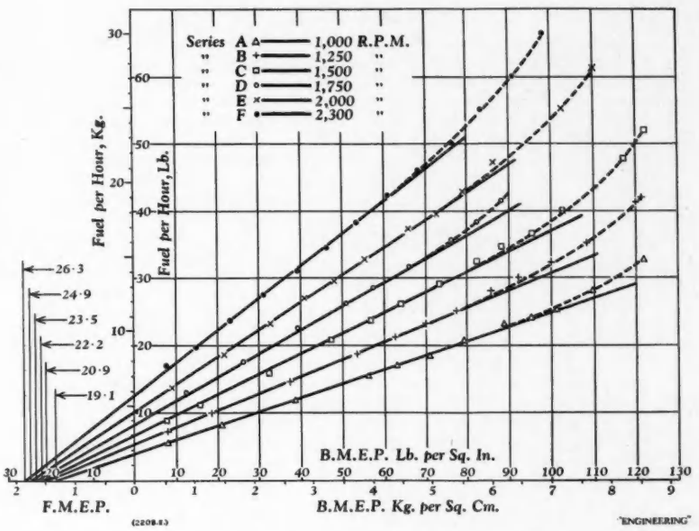

Fig. 5 Fuel consumption and brake mean - effective pressure at different speeds, showing friction mean - effective pressure.

the piezo-electric effect was used, and, under the exacting conditions of temperature and pressure in the energy chamber, difficulty was experienced from the loss of electrical charge by the quartz. By the kindness of Messrs. Dobbie McInnes, of Bothwell-street, Glasgow, the makers of the "Farnboro" indicator, one of these instruments was made available for the tests.

INDICATOR DIAGRAMS

The Farnboro diagrams to be described fall into three groups. In the first Group, K, three pairs of diagrams were taken with normal injection setting, at light load, half load, and at a load approaching full, at the same speed, each pair showing the diagrams from the main and energy chambers, respectively. In the second group, L, the speed remained the same and the load had a value approaching full, and three diagrams were taken from the main chamber, with the normal injection angle, with early injection, and with late injection, respectively. In the third group, M, the speed was varied from 1,000 to 2,200 r.p.m., and the loads

TABLE IV.

Test No.	R.p.m.	B.M.E.P., lb. per sq. in.	I.M.E.P., lb. per sq. in.	Injection Advance, deg.	Fuel, lb. per b.h.p. per hr.	Fuel, lb. per i.h.p. per hr.	Maximum Pressure in Main Chamber, lb. per sq. in.
K1	1,000	100·0	119·1	25·0	0·404	0·339	823
K2	1,035	59·0	78·1	25·0	0·420	0·317	751
K3	1,000	4·5	23·6	25·0	—	—	588
L1	1,000	100·0	119·1	25·0	0·404	0·339	823
L2	990	97·5	116·6	31·0	0·482	0·403	575
L3	990	97·5	116·6	16·0	0·402	0·337	1,015
M1	1,000	100·0	119·1	25·0	0·404	0·339	823
M2	1,250	99·6	120·5	22·5	0·404	0·334	837
M3	1,510	99·6	121·8	20·0	0·407	0·333	739
M4	1,770	98·4	122·0	15·0	0·413	0·333	763
M5	2,200	95·0	120·8	2·0	0·447	0·352	940

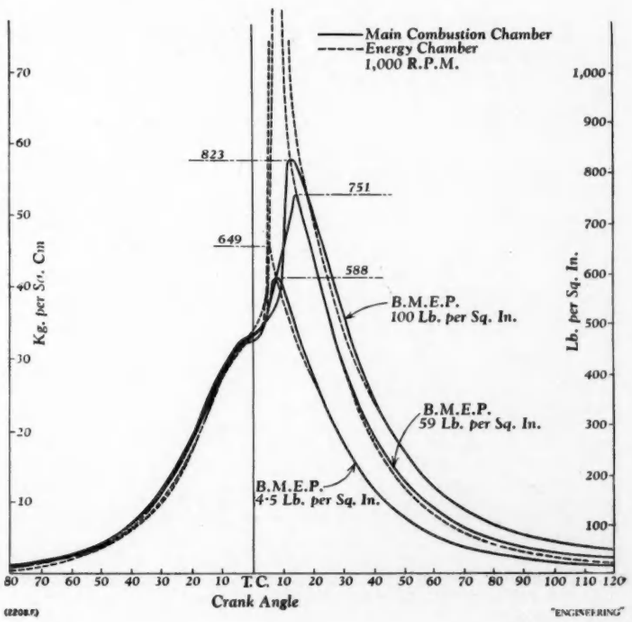

Fig. 6 Indicator diagrams showing pressure variations in the main and the energy chambers at different loads.

TABLE V.

Test No.	R.p.m.	B.M.E.P., lb. per sq. in.	B.h.p.	I.M.E.P., lb. per sq. in.	Fuel lb. per hr.	Fuel lb. per B.h.p. per hr.
N 1	1,012	30·9	20·6	50·0	10·88	0·528
N 2	1,013	42·2	28·2	61·3	13·37	0·474
N 3	1,023	51·8	34·8	70·9	15·67	0·450
N 4	1,014	57·9	38·6	77·0	16·68	0·432
N 5	998	65·3	42·9	84·4	17·86	0·416
N 6	1,016	72·5	48·5	91·6	20·00	0·413
N 7	1,006	80·2	53·1	99·3	21·62	0·407
N 8	1,016	85·9	57·4	105·0	23·58	0·411
N 9	1,021	94·6	63·6	113·7	25·75	0;405
N10	1,012	101·4	67·5	120·5	27·17	0·403
N11	1,013	108·2	72·2	127·3	29·17	0·406
N12	1,000	114·7	75·6	133·8	31·10	0·412
N13	1,016	120·4	80·5	139·5	33·85	0·421
N14	1,000	121·4	80·0	140·5	33·70	0·421
O 1	1,980	22·9	29·8	47·8	20·50	0·687
O 2	1,995	31·3	41·1	56·2	23·75	0·578
O 3	1,994	38·7	50·8	63·6	26·43	0·520
O 4	2,014	46·5	62·0	71·4	29·93	0·483
O 5	1,988	53·2	69·8	78·1	32·40	0·464
O 6	2,000	60·7	80·0	85·6	35·84	0·448
O 7	2,009	68·1	90·2	93·0	39·82	0·441
O 8	1,998	76·4	100·6	101·3	43·28	0·430
O 9	2,000	83·2	109·4	108·1	47·05	0·430
O10	2,002	90·2	118·7	115·1	50·70	0·427
O11	1,996	97·8	128·5	122·7	54·80	0·426
O12	2,000	105·3	138·6	130·2	60·40	0·436
O13	2,024	112·4	150·0	137·3	68·00	0·453

were set at values approaching full, and diagrams were taken from the main chamber. The relevant data for the three groups are set out in Table IV, and include the values of the B.M.E.P. and brake specific fuel consumption measured while the diagrams were being taken. Although they were taken some time later, there is good agreement with the values in Table I. The values of I.M.E.P. and indicated specific consumption were calculated using the values of F.M.E.P. given in Table II, adjustments being made for the actual values of revolutions per minute.

The diagrams of group K are given in Fig. 6, and demonstrate the basic differences between the processes in the main chamber and those in the auxiliary or energy chamber. In the latter, at about full and half load, diagrams K1 and K2, the rise of pressure is seen to take place considerably earlier and to be much more rapid than that in the main chamber; the maximum values reached in the energy chamber are also clearly much higher although, as the pressures in this chamber exceeded the range possible with the indicator springs used, they cannot be given. At light load, diagram K3, the differences between the diagrams in the two chambers are slight. The diagrams from the main chamber show that the rates of pressure rise there are low and that the maximum values reached, even at full load, are relatively much lower than in many other designs. The influence of the outward flow of the gases from the energy chamber upon the processes of combustion in the main chamber can be deduced from the diagrams, which confirm that, with this injection setting, the combustion in the main chamber is completed early. Altogether, this group of diagrams provides ample evidence in support of the explanation of the combustion processes given earlier in this report.

Fig. 7 shows the three diagrams of group L, and consideration of these reveals that the rates of rise of pressure and the maximum pressures in the main chamber increase rapidly as the injection is advanced. The normal setting, diagram L1, gives low values of both of these quantities. Although the later setting, L2, gives a much lower value of the maximum pressure, the combustion is so delayed that, as the values of fuel consumption in Table IV show, the thermal efficiency is very adversely affected. On the other hand, there is no gain in thermal efficiency to be expected from advancing the injection beyond the normal setting to the early one of diagram L2, in which the pressure loading is much higher.

The five diagrams of the third group, M, are shown in Fig. 8. From the data of Table IV it is seen that the I.M.E.P. is constant within a range of plus and minus 1·2 per cent. of the mean, and that the indicated specific consumption for the tests M1 to M4 is even more constant, but in test M5 is slightly higher. The values of the maximum pressure are all low except for the last test in which, from an impression drawn from the results for group L, it would appear that the injection advance is excessive. Nevertheless, the conclusion is clear that, coincident with the good values of mean effective pressure and specific consumption throughout, the claim made for the system that it gives low piston loading is justified.

TESTS WITH SHALE OIL AS FUEL

In addition to the basic tests of which the data are tabulated in Table I, two series of tests at constant speed and covering the range from light to full load were carried out under the same conditions, but using a shale oil as fuel. The two series were N at 1,000 r.p.m. and O at 2,000 r.p.m., and the test data are given in Table V; the headings are the same as those in Table I, but the fifth column, I.M.E.P., is additional. The values in this column were found by using the values for F.M.E.P. given in Table II corresponding to the two speeds; these values, as would be expected, were consistent with the results obtained for these two series by plotting the fuel consumption in pounds per hour on a base of M.E.P., but it was deemed unnecessary to give the figure.

The shale oil was similarly submitted for test to Professor Kneule and Professor Loschge at the Technische Hochschule, Munich, from whose reports the following data are extracted: specific gravity, 0·868 at 59 deg. F. (15 deg. C.); higher calorific value, 19,161 B.Th.U. per lb. (10,645 kcal. per kg.); lower calorific value, 18,158 B.Th.U. per lb. (10,088 kcal. per kg.); carbon content, 89·1 per cent.; hydrogen content, 10·4 per cent.; cetane number, from engine test, 45, and, as calculated, 49; and mean distillation temperature, 544·6 deg. F. (284·8 deg. C.). This fuel, in comparison with the gas oil used in the basic tests, is considerably denser, shows somewhat smaller calorific values, a considerably lower cetane number, and a slightly higher mean distillation temperature.

The test data of Table V are plotted as brake specific fuel consumption on a base of B.M.E.P. in Fig. 9. In comparing these curves with those for the corresponding speeds in Fig. 4, that is, N with A, and O with E, it is first seen that the values of minimum specific fuel consumptions are increased from 0·381 to 0·403 in the series at 1,000 r.p.m. and from 0·413 to 0·426 in the series at 2,000 r.p.m., differences partly to be accounted for by the smaller calorific values of the shale oil. Secondly, the forms of the curves are similar and the values of the B.M.E.P. attained are even higher in the series N and O. These tests afford evidence of the adaptability of the system of combustion to a fuel of lower combustion quality.

MEASUREMENT OF SMOKE DENSITY

In order to observe the state of the exhaust the test installation was equipped with the Schweitzer smoke meter, which has been adopted by the Co-ordinating Research Council.* In this apparatus the percentage smoke is given by (100 minus the meter reading), 100 being given by pure air, and the meter reading showing the photo-electric effect from the projected light when the exhaust gases under test are passed

* See P. H. Schweitzer: *S.A.E. Quarterly Transactions*, July 1947, vol. 1, No. 3. Also L. D. Derry, E. M. Dodds, E. B. Evans and D. Royle. Paper presented to I.Mech.E. on January 8, 1954.

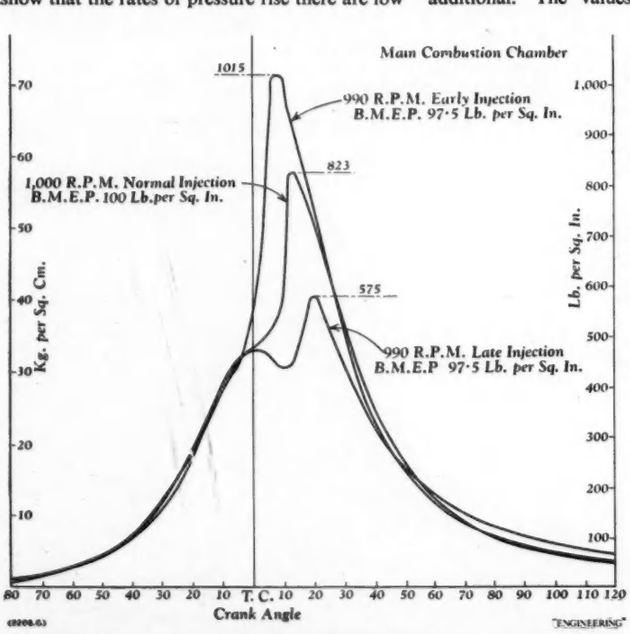

Fig. 7 Indicator diagrams showing pressure variations in main chamber with different injection settings.

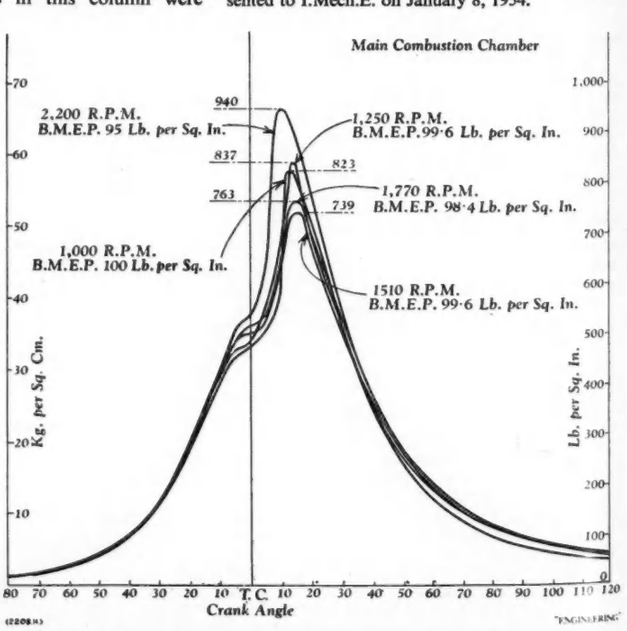

Fig. 8 Indicator diagrams showing pressure variations in main chamber at different speeds.

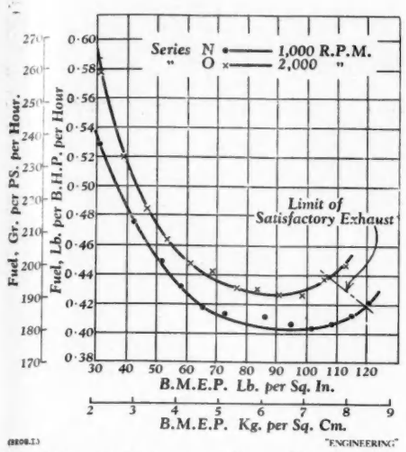
Series N ●—— 1,000 R.P.M.
" O ×—— 2,000 "
Limit of Satisfactory Exhaust
Fuel, Gr. per PS. per Hour.
Fuel, Lb. per B.H.P. per Hour
B.M.E.P. Lb. per Sq. In.
B.M.E.P. Kg. per Sq. Cm.
"ENGINEERING"

Fig. 9 Specific fuel consumption and brake mean-effective pressure with shale oil as fuel.

through the apparatus. The values of percentage smoke, observed in the tests of series A to F, N, and O, are plotted as ordinates on a base of I.M.E.P. in Fig. 10, the scale being given at the left. The corresponding values of smoke density are given by: $\log_{10}(100 \div \text{meter reading})$ and are set out at the right of the figure. Fair curves are drawn for the series A, E, N and O, firm lines for series A and E with gas oil, and broken lines for series N and O with shale oil as fuel. Further lines would unduly complicate the graph.

Derry, Dodds, Evans, and Royle, in their paper, put forward the view that a smoke density of 9·15, which corresponds to 29·2 per cent. smoke with the meter, is the limit of satisfactory exhaust, or, as they call it, the "acceptable limit." This value is marked on Fig. 10 by a horizontal line. The values of I.M.E.P. at which the probable line for each series would cut this horizontal are estimated, and, from the tables, the corresponding probable values of B.M.E.P. are interpolated, and are plotted as the dotted curves in Figs. 4 and 9, marked "limit of satisfactory exhaust." The values of B.M.E.P. reached with a satisfactory exhaust at the lower speeds are very high, which is a good feature in an engine for transport. The values naturally fall off as the mechanical losses increase with speed: from 1,000 to 2,000 r.p.m., the values range downwards from 116 to 104 lb. per square inch in Fig. 4, and from 120 to 107 lb. per square inch in Fig. 9.

In his paper, Schweitzer pointed out that he had found that fuels with a high cetane number, other properties being equal, have a greater tendency to give smoke in the exhaust than those with lower cetane numbers. This was confirmed by Derry, Dodds, Evans and Royle, and further confirmation is given in Fig. 10 from the relative positions of the lines in each pair of lines, at 1,000 and 2,000 r.p.m. respectively. The superiority in this respect of fuels with lower cetane numbers leads to the higher values of B.M.E.P. at the limit with the shale oil, 120 against 116 lb. per square inch with the gas oil at 1,000 r.p.m., and 107 against 104 lb. per square inch at 2,000 r.p.m.

The information in Fig. 10 is interesting as showing a useful order of consistency with this method of observing the state of the exhaust. Although the method may have drawbacks, its superiority over direct visual observation is not to be doubted. With more data available for comparison, improvements in accuracy may well follow.

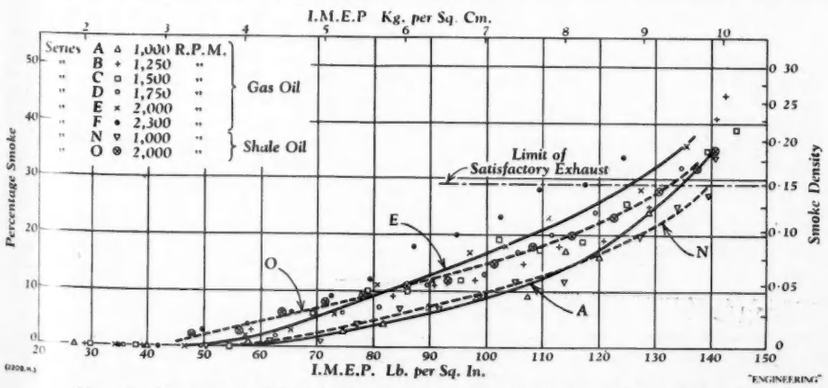

Fig. 10 Comparisons of smoke in the exhaust gases with gas oil and shale oil.

CONCLUSIONS

In connection with the objects of the present investigation into the Lanova combustion system, the observations with the smoke meter afford further evidence of the satisfactory performance of the engine over wide ranges of speed and load. When, to this performance, the combination of the high values of B.M.E.P. and the low values of brake specific consumption recorded, on the one hand, and the low loading on the pistons shown by the indicator diagrams, on the other hand are added, this improved design of the Lanova combustion system can be held to justify the claims made for it.

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COURSES ON GAS TURBINES

Theory and Practice of Aeronautical and Industrial Applications

The School of Gas Turbine Technology, Farnborough-place, Farnborough, Hampshire, have issued a programme of courses to be held during the 1954-55 session. The design courses in aeronautical or industrial gas turbines are of post-graduate standard, and include the running and testing of engines together with performance calculations. The industrial design courses also include lectures on economics and on the use of gas turbines for power generation, ship propulsion, land traction, and process-plant installations. International courses covering the design of both aeronautical and industrial gas turbines are also available. Practical aeronautical courses will be held covering stripping, assembly, and constructional details; for these courses a high standard of academical knowledge is not required.

Industrial design courses will be held from August 9 to 27, 1954, from November 29 to December 17, 1954, from February 14 to March 4, 1955, and from July 11 to July 29, 1955. Aeronautical design courses will be held from October 11 to 29, 1954, from January 17 to February 4, 1955, and from April 18 to May 6, 1955. Two international design courses are to be held from September 13 to October 1, 1954, and from March 21 to April 7, 1955. Practical aero engine courses will be held from October 18 to 29, 1954, from November 8 to 19, 1954, from January 3 to 14, 1955, from March 7 to 18, 1955, from May 16 to 27, 1955, and from June 27 to July 8, 1955. Special courses in the theory and design of compressors will be held from June 6 to 10, 1955, in the theory and design of turbines from June 13 to 17, 1955, and in combustion and heat exchangers from June 20 to 24, 1955.

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REMOTE OBSERVATION OF PRESSURE

Measurements Transmitted Pneumatically

A transmitter, which uses a pneumatic signal to transmit pressure values to remote indicators, has been developed by George Kent Limited, Luton. The instrument is a transmitter only and does not include any recording or indicating mechanisms. Any normal pressure or suction can be measured, it being converted to an air signal which bears a linear relationship to it. This air signal is then fed to a receiving instrument which continuously indicates or records the measured value. Once the initial setting has been carried out, the transmitter requires little attention.

For pressure ranges from 15 to 2,000 lb. per square inch, a Bourdon tube is used as the measuring element, while for suctions and pressures below 15 lb. per square inch, a bellows type unit is employed. The measuring element is connected by a linkage to the maker's standard transmitter which generates the air signal that is fed to the receiver. The transmitter operates on the standard air pressure of 17 lb. per square inch, which is taken from the main air supply through a filter and a combined relay/pressure reducer, both being mounted in the transmitter case. Gauges, also mounted on the case, indicate the "supply" and "transmission" pressures.

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CAREERS IN RADIO AND ELECTRONICS

4,000 Entrants a Year

Recruitment is as necessary for the radio and electronics industries as in any other, and a booklet has been issued by the Radio Industry Council as a guide for those leaving school or college. Entitled "Careers in Radio and Electronics," the booklet gives a picture of what is included in the industry and methods of entry at different levels. About 3,000 school leavers can be absorbed in the industry each year as well as 1,000 graduates.

A section of the booklet is devoted to a description of the field that is covered by the term "electronics"; it is a wide one. The structure of the industry is described and the possibilities of advancement stressed. Another part deals with the qualifications required for entry at the different levels, and how these may be obtained. The booklet, which is illustrated, is to be distributed to public, grammar and technical schools throughout the country either directly or through the Ministry of Labour. If desired copies may be obtained directly from the secretary of the Council at 59 Russell-square, London, W.C.1.

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INSPECTION OF COPPER-BASE ALLOY CASTINGS

Code of Procedure Published

An inspection procedure for copper-base alloy castings used in all Ministry of Supply contracts, and the sub-contracts arising from them, has been agreed between the Ministry and the Association of Bronze and Brass Founders, and is set out in "A Code of Procedure to Facilitate the Co-ordination of Inspection for Copper Base Alloy Castings Ordered by the Ministry of Supply," shortly to be issued by the Association, 69 Harborne-road, Birmingham 15 (price 5*s.* post free). The Association points out that not only founders but all Ministry contractors and sub-contractors will require copies of the code. The latter will come into force on September 1.

Fig. 1 The towing tank, 618 ft. long and 8 ft. wide, with a maximum depth of 4 ft., is semi-circular in section and is constructed of Alclad sheeting suspended from a framework built up from mild-steel channel sections. Fig. 2 shows the tank during construction. The brickwork building housing the tank was constructed subsequently.

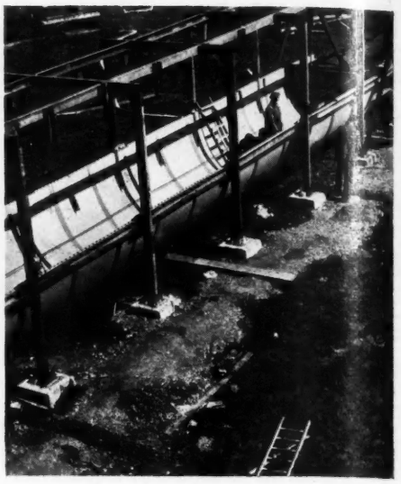

Fig. 2

HYDRODYNAMIC DEVELOPMENT FACILITIES

TESTING WATER-BASED CRAFT AT SAUNDERS-ROE, LIMITED

The particular interest of the hydrodynamic test facilities available at Saunders-Roe, Limited, East Cowes, Isle of Wight, for proving and developing the capabilities of water-based aircraft, high-speed launches, racing and other marine craft, pontoons, etc., lies in their economical and simple construction and in their potentiality for enabling development tests to be carried out at high intensity. This is achieved partly by successful tank design and partly by using simple, reliable mechanical apparatus wherever this is feasible in place of complex electronic gear which requires elaborate setting up. (Electronics are, however, employed where a particularly high degree of precision is desired.) In this article we describe the towing tank and the free-launching tank designed and constructed by the company, together with the associated power supplies and instrumentation. We are indebted to Mr. W. A. Crago, tank superintendent, for the information.

DYNAMIC SCALE MODELS

Most of the work carried out by the Saunders-Roe hydrodynamics test department is concerned not only with determining the overall resistance of hull forms but also with the response of the craft to waves and disturbances, with spray formation and, in the case of aircraft, with the alighting and take-off behaviour and effect of impact accelerations. In general, therefore, it is necessary to employ "dynamic" models, reproducing to scale the dimensions, weight, centre of gravity and moment of inertia of the full-scale craft.

The towing tank was originally designed to test flying-boat and high-speed planing-craft models, and hence it was possible to make the cross-section of the tank smaller than usual (the tank is 8 ft. wide and 4 ft. deep). For flying boats, wing spans are restricted to 8 ft. and hull lengths to about 5 ft.; for motor boats, etc., the hull lengths are kept below 4 ft. in order to avoid boundary interference. The models are made of hollow balsa wood blocks and Beetle glue, lead weights being added in appropriate positions. In the case of flying boats, Perspex inserts provide the necessary sharp edges at the chines.

Models of propeller-driven aircraft are provided with power-driven propellers producing scale thrust and slipstream lift for dynamic tests in the towing tank. A recent technique for making such propellers is by moulding them in Marco resin. They are driven by small compressed-air turbines supplied, through the model supporting structure, from compressed-air bottles mounted behind the towing carriage. In the model Princess flying boat are installed 2-h.p. 50,000-r.p.m. compressed-air turbines and associated gearing for driving the propellers. This model is also fitted with leading-edge slats not present on the full-scale aircraft; the purpose of these is to compensate for scale effects on the lift characteristics at low speed.

SUSPENDED ALUMINIUM-ALLOY TOWING TANK

The construction of the towing tank (Fig. 1) is probably unique. In order to use surplus materials available in the works at the time of its construction – 1948 – the tank, which is 618 ft. long by 8 ft. wide, with a maximum depth of 4 ft., is of semi-circular cross section and is made up of 16 s.w.g. Alclad sheeting joined by plywood butt-straps. Fig. 2 shows the tank during construction. It was originally envisaged as a temporary measure, but after six years of continuous use there is no sign of serious corrosion although some slight crystalline growth is evident.

The tank is hung from a framework of mild steel channels which were previously used in erection jigs for Walrus aircraft, the vertical members of this framework being embedded in concrete blocks. Construction joints are provided to allow for expansion and contraction. Along the top of the framework are rails for the travelling carriage which tows the model under test and which houses the measuring gear. At a station about half-way along the tank, electric contacts are built into the track to provide for automatic operation of a camera and electronic flash gear, when required.

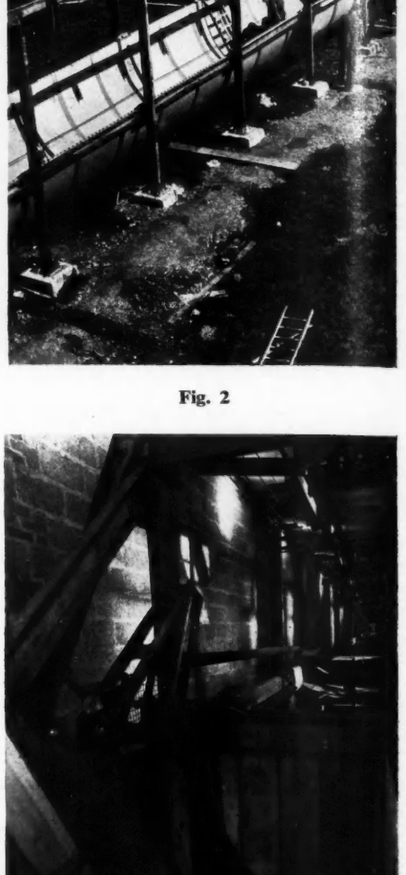

Fig. 3 The adjustable-stroke mechanism for the towing-tank wave-maker, driven by a hydraulic motor.

To suppress wave formation resulting from the passage of the model down the tank, detachable sloping "beaches" are provided along the sides of the tank. They are so effective that it is possible, with some models, to carry out continuous testing, with no delay at all between the runs. The firm, in fact, believe it to be the most intensively-operated testing tank in the Western Hemisphere.

The beaches are removed when it is desired to make waves in the tank. At the remote end is a wave-maker comprising a paddle pivoted at its lower edge to the bottom of the tank. The paddle is connected by a linkage to a variable-stroke connecting rod which is coupled to a heavy flywheel driven by a hydraulic motor (Fig. 8). The power supply for the latter is furnished by an electro-hydraulic generator.

TOWING CARRIAGE AND DRIVE

The carriage (Fig. 4) provides seats for two observers at the front, and two couches at the

back for observers recording the instrument readings when the six-component balance is in use. It runs on six wheels on the two overhead rails, and is propelled by an endless wire rope, the tension of which can be taken up by a lead screw at the far end of the tank. Limit switches are provided at each end of the travel, 170 ft. being allowed at the far end for decelerating the carriage.

The endless wire rope is driven, through a rope drive and reduction gearing, by a B.T.H. 35-h.p. direct-current motor controlled by a Ward Leonard set. The power supply is provided by a B.T.H. 49-h.p. motor-generator set housed in a separate shed.

The carriage is controlled from a desk, constructed by Saunders-Roe, Limited, at the forward end of the tank building; the only control provided on the carriage is a push-button which allows the carriage occupants to stop or decelerate the carriage, but not to initiate motion. The forward motion is controlled electronically; the carriage can be accelerated from rest to a preselected speed, constant acceleration or speed being maintained (to within $\pm$ 0·1 ft. per second for speed) by the electronic equipment until the desk operator actuates the stopping or deceleration switches, or the automatic brakes come into action. The maximum attainable acceleration is $\frac{1}{4}$ *g*, and the top speed is 50 ft. per second, but 40 ft. per second is not often exceeded

REGENERATIVE BRAKING

There are four separate systems of braking. Regenerative braking is employed during the controlled deceleration period, the kinetic energy of the carriage being fed back to the motor-generator set. The degree of regenerative braking can be controlled by a potentiometer incorporated in the electronic control gear. Secondly, dynamic braking comes into action automatically as soon as the carriage contacts either of the limit switches, bringing into the motor circuit a dynamic braking resistor in which the energy of the carriage is dissipated as heat. When the carriage is travelling forward at high speed the dynamic braking effect is not sufficient and a preset mechanical brake is also applied automatically. After each operation, the mechanical brake has to be reset by the operator. An overspeed trip automatically brings the dynamic and mechanical brakes into action if the carriage speed exceeds a predetermined speed – generally 40 ft. per second. As a final precaution, there is a ramp brake at the far end of the track which engages with shoes on the carriage if the latter has not been brought to rest by the other systems. Buffers are also provided to eliminate any possibility of the carriage crashing into the brick wall of the tank building.

On the reverse motion, the motor driving the carriage is controlled at a constant speed by separate automatic contactor gear until the limit switch is tripped or the stopping switches are operated. Inching, forward or reverse, is not controlled by the limit switches and can be carried out in any part of the tank.

The preselector push-buttons on the control desk, which are translucent, cannot be operated unless they are illuminated by indicator lights to show that the sequence of operations which each controls can be safely started. There are five of these push-buttons – accelerate, decelerate, reverse, inch forward, inch reverse. Green indicator lamps tell the desk operator whether the carriage is accelerating, has reached top speed, or is decelerating; red lights show if the carriage has stopped or is reversing. A dial indicator records the carriage speed, and a second dial indicates rope slip, which may be present in very highly accelerated runs, to enable the reading of the carriage-speed dial to be corrected.

TOWING-TANK DYNAMOMETERS

The carriage is provided with two separate dynamometer systems – a main six-component balance situated inside the carriage on which the loads are measured electronically, and a mechanical balance for use with dynamic models at the forward end of the carriage, visible in Fig. 4, for measuring resistance only. It is perhaps typical of the whole set-up of the test department that the simple dynamic balance, constructed in two days at a fraction of the cost of the main balance, has proved to be a more useful development tool than the latter. It is extremely reliable and accurate to within $\pm$ 0·02 lb. and can measure drags up to 10 lb.

Considering first the dynamic balance, a diagram of which is reproduced in Fig. 5, the test model is pivoted on a hollow centre post which can move vertically in ball races mounted in a box frame. The latter, free to move over a range of fore-and-aft movement of 0·2 in., is suspended by leaf springs on swinging gates which are themselves similarly suspended on the balance frame-work which is rigidly attached to the carriage. If necessary, a non-dynamic model may be counterbalanced by means of a pulley and weight system.

The drag force on the model is indicated by a pointer moving over a scale, in conjunction with weights which may be used to balance out the major part of the force. Fluctuations are damped by a dashpot.

The six-component balance, a highly sensitive instrument of rigid welded and bolted construction with an accuracy of $\pm$ 0·005 lb. and a capacity of 40 lb., also employs a counterbalanced centre post and drag frame similar in principle to that of the dynamic balance, but restricted to only 0·016 in. movement, the motion being detected by a displacement transducer and indicated on a dial at the rear of the carriage. In order to neutralise the effect of transient accelerations, an " inertia neutraliser " is attached to the box frame. This comprises a cruciform member pivoted on crossed springs carrying a heavy lead weight at the top of the upper arm. One arm of the cruciform also serves for counterbalancing drag loads greater than 1 lb., which are beyond the capacity of the transducer, and for this purpose an " automatic " weight changer, which quickly adds or removes counterbalancing weights by turning a handle, has been devised.

The box frame is also suspended from side-force gates enabling side loads on the model to be detected in a similar manner. Yawing moment is measured by employing a double centre post, i.e., an outer tube which is constrained against rotation, with an inner concentric tube, to which the model is attached, which can rotate within the outer tube. The two tubes are linked together so that in the vertical direction they move as one.

Lift at constant draught is measured by resistance wire strain gauges mounted on a horizontal link which is deflected very slightly by a block on the centre post when the latter moves vertically. To record pitching moment at constant trim angles, each end of the model is linked to a wire-and-pulley system, the two pulleys being mounted on the same longitudinal shaft, at the top of the balance. The shaft itself is pivoted on cross-springs and its motion against coil springs is measured electronically.

THE FREE-LAUNCHING TANK

For carrying out alighting tests of water-based aircraft and assessing the ditching characteristics of landplanes, another tank, 130 ft. long

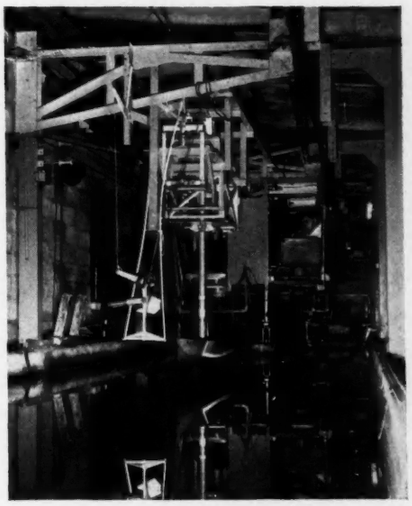

Fig. 4 The towing tank carriage; at the forward end, a motor-boat model (out of the water) can be seen mounted on the dynamic balance. A displacement craft is under test mounted on the main six-component balance. The carriage has a maximum acceleration of $\frac{1}{4}$g and a maximum speed of 50 ft. per second.

and 2 ft. deep and fitted with free-launching gear, is situated in the grounds of the Saunders-Roe works. It is illustrated in Fig. 6. This tank, equipped with both longitudinal and transverse wavemakers, is wider at the far end, providing adequate space for tests of self-propelled boat models to be carried out in rough water. Beaches are provided at the forward end of the tank to ensure that satisfactory wave trains can be produced without interference due to reflections.

The catapult launching gear for the flying models can be seen in Fig. 7. It is of the simple falling-weight type, providing an accelerating force through a 6-to-1 ratio pulley block to the launching carriage, which has an accelerated travel of 25 ft. The launching speed of the model can be varied up to 68 ft. per second by adjusting the falling weight up to a maximum value of 1 ton.

The model is suspended from the carriage on three arms, the two forward ones carrying most of the weight, being attached with a spring-loaded locking device at a point slightly aft of the centre of gravity. The third arm is attached to the tail pick-up point. When the carriage reaches the end of its travel, a cam on the track releases the locking mechanism and the model is

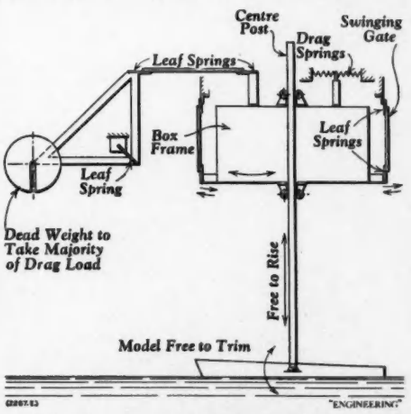

Fig. 5 Diagram of the towing-carriage dynamic balance.

Fig. 6 The free-launching tank, showing a model about to be launched at the far end, and the longitudinal wave-maker in the foreground.

projected freely into the air. The carriage is brought to rest by a friction brake and by a " bungee " cord stretched across the path of the carriage near the end of its travel.

To produce waves travelling down the length of the tank, an adjustable powered wave-maker is employed. The source of power is an old Morris motor-car engine, complete with clutch and gearbox, which drives a paddle extending across the tank through a crank, the stroke of which can be adjusted but not while the wave-maker is in operation. The transverse wave-maker, which can be used simultaneously with the main wave-maker to produce a complex wave motion, is manually operated. The behaviour of the model as it touches down, and subsequently, is recorded with a cine camera, operated usually at a speed of 64 frames per second, and subsequently the film is projected at slow speed to enable the behaviour to be studied in detail.

The launching speed is measured by means of a velocity indicator developed by the Electronics Division of Saunders-Roe Limited. It comprises two units – an electronic timer of the binary-counter type, accurate to $\pm 0{\cdot}1$ millisecond, and a lamp and photo-electric cell. The latter are mounted at the end of the launching track. Two metal blades, 12 in. apart, are mounted on the centre line of the model and are arranged to pass between the lamp and the photocell as the model is released.

As the first blade cuts off the light supply from the photocell, an electrical pulse is transmitted to the electronic timer, opening a gate circuit which allows accurately-timed pulses at 10,000 per second, produced by a crystal-controlled oscillator, to be fed to the electronic counting mechanism. The passage of the second blade past the photocell closes the gate circuit and stops the counting mechanism. The number of pulses that have been passed during 1-ft. travel of the model is indicated by a series of neon lights on the electronic timer. The latter is also provided with a dial indicating directly, in feet per second, the approximate launching velocity.

SIMPLE PRESSURE RECORDERS AND ACCELEROMETERS

In addition to studying the qualitative behaviour of the aircraft when alighting, it is necessary to assess the loads imposed upon them. Since the space and weight capacity for stowing instruments within the model is severely limited, electronic recording instruments are not generally feasible. The Saunders-Roe company have therefore devised their own ingeniously simple light-weight pressure recorders and accelerometers. These instruments are not intended as highly sensitive research tools, and do not record very transient values. Their purpose is to provide practical information on which the design office can base their strength calculations, and they have been proved to give reliable and repeatable indications when installed and interpreted by experienced personnel. They are extremely simple to manufacture, and in fact apprentice labour is used for this purpose.

The pressure gauge, illustrated in Fig. 8, is about 4 in. long and consists of a rubber diaphragm mounted in a Duralumin casing. When installed in the model, the outer face of the diaphragm is arranged flush with the hull surface. The water pressure on the hull at the point under consideration is transmitted by the diaphragm through a spring-loaded connecting rod, to a wire stylus giving a trace on a smoked Perspex screen. The height of the trace gives an indication of the pressure. The gauges are calibrated against a column of water.

The accelerometer is illustrated in Fig. 9. It consists of 12 small bar magnets fixed in slots in a mild-steel base forming the top of the instrument, and enclosed by a Duralumin casing. From the under side of the casing 12 Perspex tubes are screwed in to register with the magnets. The inner ends of the Perspex tubes are sealed to form housings for $\frac{1}{8}$ in. diameter steel balls, the latter being held in place by the magnetic field. The amount by which the Perspex tubes

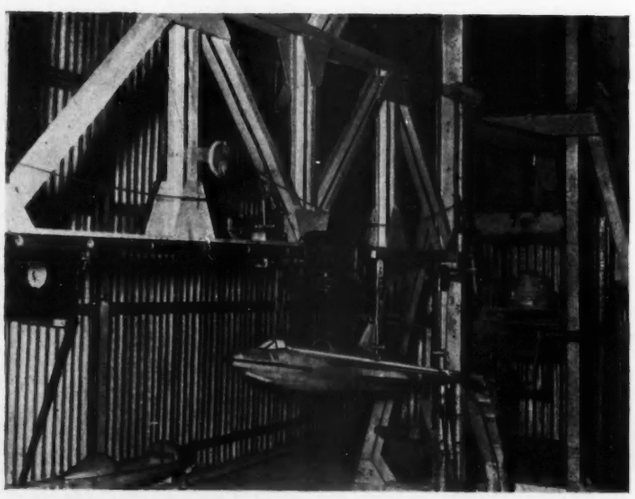

Fig. 7 The catapult gear for launching models of water-based aircraft during alighting tests. The launching speed can be varied up to 68 ft. per second.

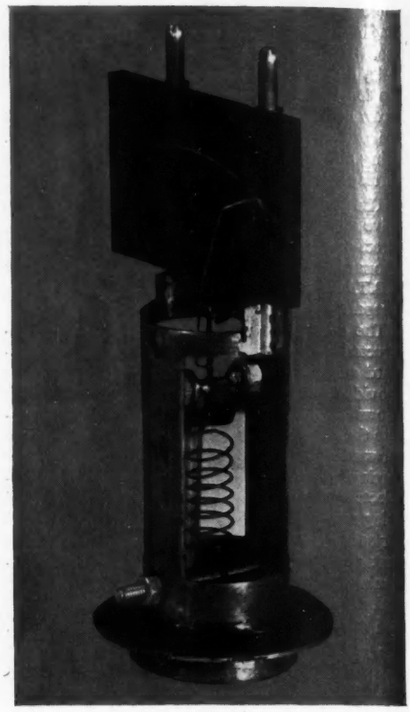

Fig. 8 Miniature water-pressure recorder. The water pressure on the hull is transmitted by a rubber diaphragm through the spring to a wire stylus recording on a smoked Perspex screen.

are screwed into the casing is adjusted to vary the distance between the ball and the magnet, so that each ball escapes from the tube when a different pre-determined normal acceleration is reached – i.e., the first ball is thrown out at $\frac{1}{2}\,g$, the second at 1 g, etc. Thus at the end of a test the number of balls that have been ejected from the tubes gives a measure of the maximum acceleration attained, with an accuracy of $\pm \frac{1}{4}\,g$ or $\pm \frac{1}{2}\,g$, depending on the calibration. The open ends of the tubes are enclosed in a Perspex casing to prevent the balls from being lost. The initial calibration of the instrument is carried out on a whirling arm, the axis of the instrument being disposed horizontally. The speed of the arm can be varied to allow each tube to be individually set to indicate the required acceleration.

To give a statistical evaluation of the loads sustained in float struts during a rough sea, particularly when a flying boat is wallowing with little or no forward speed, an adjustable micrometer is installed in the wing. This instrument is set to operate an electrical contact at a predetermined wing-tip deflection, feeding an electric current to a camera which thus records the number of times the specified load has been exceeded.

RADIO-CONTROLLED SELF-PROPELLED MODELS

Mention has already been made of self-propelled boat tests. While these are sometimes carried out in the free-launching tank, they can also be carried out on open water in the river Medina or elsewhere. Flying models are also tested in free flight, powered by small compression-ignition engines, or by rocket motors using hydrogen peroxide as fuel. In the case of flying models, the simple mechanical measuring instruments already described are used for measuring the pressures and accelerations experi-

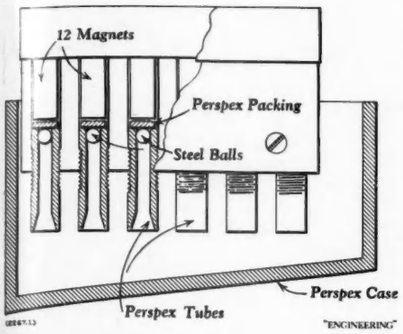

Fig. 9 Magnetic accelerometer: 12 steel balls housed in Perspex casings are held in position by a magnetic field, which is overcome at a predetermined normal acceleration, different for each ball. Thus, the number of balls ejected gives a measure of the maximum acceleration reached.

enced in take-off and landing. With the larger self-propelled boat models of the type shown in Fig. 10, however, in which the throttle and the rudder are radio-controlled, electric recording instruments supplied by the Société de Fabrication d'Instruments de Mesure (S.F.I.M.), Paris, are employed for measuring propeller-shaft thrust and torque, r.p.m., rudder position, rise, trim, and rate of turn.

The S.F.I.M. recorder is a particularly compact instrument of the mirror-galvanometer type. Measuring 6¼ in. by 4¼ in. by 3¾ in. overall, it has a built-in light source and a cine camera, and is capable of recording nine simultaneous measurements on the same film. Time-markers are also incorporated. To ensure that the accuracy is not affected by mains frequency variations, the electric motor drives the camera through a watch escapement and a slipping clutch.

The method of controlling the rudder movement adopted in some of the self-propelled boats is of particular interest in that the drive is taken from the main propulsion shaft. The radio receiver, relays and 24-volt supply for the control gear are located in the stern of the boat. The test observer operates a radio transmitter, which transmits a single-pulse signal to the receiver in the boat for each 7½ deg. of required rudder movement. Each pulse causes one of two solenoids to close, depending on the desired direction of movement, and attracts an armature linked to a swinging arm which causes a corresponding friction disc to engage with a disc on the main propeller shaft. The drive is thus transmitted, through reduction gearing, to the rudder. When the rudder has moved through a specified amount, a pawl is engaged by a ratchet wheel incorporated in the rudder reduction gear train, causing the solenoid to disengage until the next pulse is received.

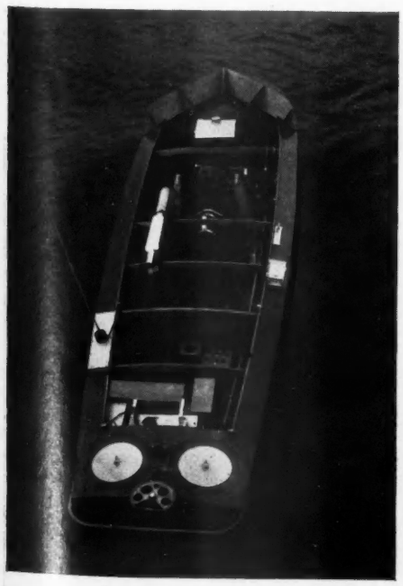

Fig. 10 A large scale-model motor boat with radio control of the throttle and rudder.

The throttle opening is similarly controlled in steps by transmitted single pulses, 14 increments being provided from " idling " to " fully open." The return to idling speed, however, is accomplished by a single pulse.

In conclusion, it may be of interest to list some of the work that has been carried out recently by Saunders-Roe. On the aircraft side, in addition to work on the Princess, a retracting water ski for a high-speed fighter project has been developed with great success, and the hull of an ocean patrol boat with a high length-to-beam ratio has been proved. On the marine side, security forbids mention of the most interesting projects, which are of highly advanced design. Some unconventional racing craft, both powered craft and yachts, have been tested for their designers, and investigations have been carried out on behalf of the Royal National Life-Boat Institution on a model of the Arbroath lifeboat which capsized in a heavy sea in the autumn of last year, resulting in the death of all but one of its crew.

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LAUNCHES AND TRIAL TRIPS

M.S. " BURCOM SAND."—Single-screw twin grab hopper dredger, built by Cook, Welton and Gemmel, Ltd., Beverley, Yorkshire, for the British Transport Commission, London. Main dimensions: 156 ft. between perpendiculars by 34 ft. by 14 ft. to main deck; spoil deadweight capacity, 800 tons on a mean draught of 12 ft. 6 in. Diesel engine developing 605 s.h.p. at 500 r.p.m., constructed by Ruston and Hornsby Ltd., Lincoln, and connected to the propeller by a 3 : 1 reverse-reduction gearbox made by Modern Wheel Drive, Ltd., Chesham, Buckinghamshire. Machinery installed by Charles D. Holmes & Co., Ltd., Hull. Launch, April 20.

M.S. " HÖEGH SWORD."—Single-screw oil tanker, built and engined by Eriksbergs Mek. Verkstads Aktiebolag, Gothenburg, Sweden, for the A/S Abaco, Aruba, Astrea and Norvega (Managers: Leif Höegh & Co., A/S), Oslo, Norway. Main dimensions: 526 ft. between perpendiculars by 69 ft. 9 in. by 39 ft. 3 in.; deadweight capacity, 18,200 tons on a draught of about 30 ft. 5 in. B. and W. six-cylinder two-stroke Diesel engine, developing 7,500 b.h.p. Speed, 15¼ knots. Launch, May 4.

M.S. " INGER SKOU."—Single-screw cargo vessel with accommodation for twelve passengers, built and engined by Burmeister and Wain, Ltd., Copenhagen, to the joint order of Ove Skou Ltd., and the Shipping Co. of 1937, Ltd., both of Copenhagen, Denmark. Main dimensions: 400 ft. between perpendiculars by 55 ft. 6 in. by 35 ft. 6 in. to upper deck; deadweight capacity, 6,950 tons on a summer draught of about 24 ft. 6 in.; cargo capacity, 430,000 cub.ft. Eight-cylinder single-acting two-stroke Diesel engine, arranged to burn heavy oil and developing 8,700 i.h.p. at 125 r.p.m. Speed, 17 knots. Delivered, May 20.

M.S. " GUNNAR KNUDSEN."—Single-screw oil tanker built and engined by the Götaverken Shipyard, Gothenburg, Sweden, for A/S Borgestad, Borgestad, Norway. Main dimensions: 550 ft. overall by 66 ft. by 39 ft. 3 in.; deadweight capacity, about 17,400 tons on a draught of 30 ft. 2 in. Götaverken nine-cylinder single-acting two-stroke Diesel engine, developing 6,750 b.h.p. at 112 r.p.m. Loaded speed, about 15 knots. Launch, May 25.

M.S. " HÖEGH SPEAR."—Single-screw oil tanker, built and engined by Eriksbergs Mek. Verkstads Aktiebolag, Gothenburg, Sweden, for the A/S Atlantica (Managers: Leif Höegh & Co. A/S), Oslo, Norway. Main dimensions: 526 ft. between perpendiculars by 69 ft. 9 in. by 39 ft. 3 in.; deadweight capacity, about 18,200 tons on a draught of 30 ft. 5 in. B. and W. six-cylinder two-stroke Diesel engine, developing 7,500 b.h.p. Speed, 15¼ knots. Launch, May 25.

M.S. " PONTIA."—Single-screw oil tanker, built by Harland and Wolff, Ltd., Belfast, for Hvalfangerselskapet " Pelagos " A/S. (Managers: S. F. Bruun), Tönsberg, Norway. Main dimensions: 465 ft. between perpendiculars by 61 ft. 6 in. by 35 ft. 6 in.; deadweight capacity, about 13,200 tons on a draught of 27 ft. 10 in.; gross tonnage, about 8,780. Harland-B. and W. six-cylinder single-acting four-stroke Diesel engine. Launch, June 2.

M.S. " BORDER FUSILIER."—Single-screw oil tanker, built and engined by R. and W. Hawthorn, Leslie & Co., Ltd., Hebburn-on-Tyne, County Durham, for the Lowland Tanker Co., Newcastle-upon-Tyne. Main dimensions: 547 ft. overall by 69 ft. 6 in. by 37 ft. 6 in. to upper deck; deadweight capacity, about 16,100 tons. Hawthorn-Doxford six-cylinder opposed-piston oil engine, developing 6,400 b.h.p. at 115 r.p.m. in service. Trial trip, June 9 and 10.

M.S. " PRESIDENT BRAND."—Single-screw oil tanker, built by the Furness Shipbuilding Co., Ltd., Haverton Hill, County Durham, for the Northern Steamships Ltd., Johannesburg. Main dimensions: 560 ft. between perpendiculars by 80 ft. by 42 ft. 3 in. to upper deck; deadweight capacity, about 24,575 tons on a draught of 32 ft. 3⅛ in. N.E.M.-Doxford six-cylinder single-acting two-stroke opposed-piston oil engine, developing 6,800 b.h.p. at 119 r.p.m., constructed by the North Eastern Marine Engineering Co. (1938), Ltd., Wallsend-on-Tyne. Speed, 14 knots. Launch, June 17.

M.S. " VERONA."—Single-screw oil tanker, built and engined by the Götaverken Shipyard, Gothenburg, Sweden, for Skibs A/S Eidsiva, Skibs A/S Smaatank, and Skibs A/S Vaarheim, Oslo, Norway. Main dimensions: 550 ft. by 66 ft. by 39 ft. 3 in.; deadweight capacity, about 17,400 tons on a draught of 30 ft. 2 in. Götaverken nine-cylinder single-acting two-stroke Diesel engine, developing 6,750 b.h.p. at 112 r.p.m. Loaded speed, about 15 knots. Launch, June 22.

M.S. " VASARA."—Single-screw vessel for carrying oil and ore, built and engined by the Götaverken Shipyard, Gothenburg, Sweden, for Trafikaktiebolaget Grängesberg-Oxelösund, Stockholm, Sweden. Main dimensions: 596 ft. overall by 74 ft. 6 in. by 44 ft. 3 in.; deadweight capacity, 21,750 tons on a mean summer draught of 31 ft.; oil-cargo capacity, 805,000 cub. ft. Götaverken nine-cylinder single-acting two-stroke Diesel engine, arranged to burn heavy oil and developing 6,750 b.h.p. at 112 r.p.m. Speed, 14½ knots, fully loaded. Delivered, June 24.

S.S. " CERINTHUS."—Single-screw oil tanker, built and engined by Harland and Wolff, Ltd., Belfast, for the Hadley Shipping Co., Ltd., London, E.C.3. Main dimensions: 530 ft. between perpendiculars by 69 ft. 3 in. by 39 ft. to upper deck; deadweight capacity, 18,000 tons. Double-reduction geared steam turbines, developing 7,500 s.h.p. in service. Steam supplied by two Babcock and Wilcox oil-burning water-tube boilers. Launch, June 29.

S.S. " CICERO."—Single-screw vessel for carrying general and refrigerated cargoes, with accommodation for twelve passengers, built by Henry Robb, Ltd., Leith, to the order of Ellerman's Wilson Line, Ltd., Hull, for service to Mediterranean and Scandinavian ports. First vessel of two. Main dimensions: 290 ft. between perpendiculars by 48 ft. 6 in. by 27 ft. to upper deck; deadweight capacity, 2,400 tons on a mean draught of 17 ft. 9 in. Triple-expansion direct-acting surface-condensing marine reciprocating engine, working in conjunction with a Bauer-Wach exhaust steam turbine. Main engine supplied by Swan, Hunter, and Wigham Richardson, Ltd., Wallsend-on-Tyne, and the exhaust turbine by Barclay, Curle & Co., Ltd., Whiteinch, Glasgow. Service speed, 13 knots. Delivered, June 29.

LIGHT VESSEL No. 16.—Built by Philip and Son, Ltd., Dartmouth, for the Corporation of Trinity House, London, E.C.2. Twenty-fourth light vessel constructed for the Corporation. Main dimensions: 130 ft. by 25 ft. by 15 ft.; gross tonnage, 350. The lantern contains six 500-watt lamps, giving a beam visible for from 10 to 12 miles in clear weather. Launch, July 1.

M.S. " FREDERICK T. EVERARD."—Single-screw cargo vessel, built by the Goole Shipbuilding and Repairing Co., Ltd., Goole, for F. T. Everard and Sons, Ltd., London, E.C.3. Main dimensions: 285 ft. by 42 ft. by 19 ft. 3 in.; deadweight capacity, 3,300 tons. Diesel engine developing 1,600 b.h.p. at 250 r.p.m., constructed by the Newbury Diesel Co., Ltd., Newbury, Berkshire. Launch, July 1.

THE BRITISH CAST IRON RESEARCH ASSOCIATION

ANALYTICAL AND TESTING EQUIPMENT AND RESEARCH

At a recent "Open Day" arranged by the British Cast Iron Research Association, Bordesley Hall, Alvechurch, Birmingham, we were able to see something of the progress made by the Association since 1952, when the previous "Open Days" were held.

APPARATUS AND INSTRUMENTS

A considerable amount of new equipment has been installed, and new buildings have been provided to accommodate the spectrographic and chemical laboratories. The building of a new experimental melting shop has also been completed, but it is not yet equipped. Equipment in the spectrographic laboratory includes a Hilger quartz prism spectrograph and a 2-metre diffraction-grating spectrograph. The major item in this laboratory is, however, a direct-reading spectrographic, production-control quantometer, made by the Applied Research Laboratories, Glendale, California, U.S.A. This equipment, which is calibrated to deal with ten elements, has now been in use for two years, and a considerable amount of operational experience has been accumulated.

The chemical laboratory, which adjoins that housing the spectrographic apparatus, has been completed and occupied during the last year. It is arranged for regular analysis of all types of cast iron, and for research work on the development of new analytical methods. Some of the work in the laboratory was demonstrated by the use of actual apparatus, such as the Spekker absorptiometer and the Uvispek spectrophotometer, and by displays showing, for example, cathodic protection of cast-iron pipes buried in the earth.

Some of the smaller laboratories are accommodated in the former country house, Bordesley Hall, which also contains the administrative offices, the library, and the Intelligence Department; the latter is responsible for editing all the Association's published matter, and also for dealing with inquiries which can be answered from published sources. Other laboratories are housed in adjacent buildings. Each of the laboratories is engaged in the investigation of specific problems, such as surface finish of iron castings, the use of strain gauges and triangular test grids for studying residual stresses, and thermal analysis of solidification sequences. A separate laboratory deals with metallographic and photographic work, and the investigation of moulding-material problems is carried out in three adjoining sands laboratories. There is an extensive mechanical-testing laboratory, fully equipped with machines for tensile, compression, shear, transverse, impact, creep and hardness testing; fatigue testing is carried out in a separate room equipped with Wöhler-type machines.

RESEARCH PROGRAMME

The Association conducts research into problems and developments fundamental to the iron-casting industry as a whole, and into specific problems brought forward by member firms. Among the subjects being studied at present are: gases in cast iron, graphite formation, soundness of castings, mechanical properties of various types of cast iron, the properties of moulding and core sands and shell moulds, the evolution of gases from cast iron during enamelling, white and chilled irons, and spectrographic analysis.

The work undertaken sometimes involves the use of apparatus which is not commercially available, and in this case the necessary equipment is designed and made on the premises. A fully-equipped engineering workshop provides facilities for the manufacture of such apparatus, and for the maintenance of other plant. The preparation of samples is also undertaken in this workshop. In addition, the workshop builds or adapts prototype equipment for use in foundries, which has been developed as a result of research work. An example of the latter is the decoring bar evolved by the Foundry Atmospheres Team. This bar incorporates a water spray, for dust control when breaking cores out of castings. Similarly, this team has developed a pedestal grinder, with apparatus for dust control, which has been made and tested on the premises, and has since been marketed commercially. The work of the Foundry Atmospheres Team is, incidentally, given added significance by the section of the Iron and Steel Foundries Regulations, 1953, dealing with dust and fumes, which will come into force in January, 1956.

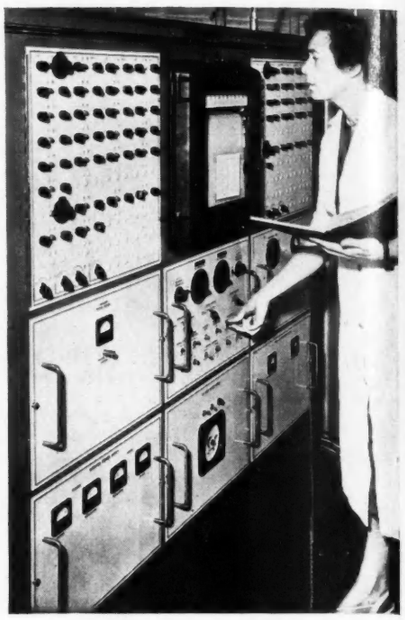
SAND HEATER

An example of the apparatus designed and built specially for the investigation of a particular problem is the very-high-frequency heater developed to study the behaviour of foundry sands under load at high temperatures. Heating of the sand specimens by any normal furnace would be relatively slow, and by the time the required temperature was reached, the clay, coal dust and pitch contents of the specimen would have been burnt out. The Association have, therefore, developed a special dielectric heater, operating at 100 megacycles per second, which is capable of heating a small sand specimen, while it is under a predetermined load, to a temperature of 1,000 deg. C. in 2½ minutes. The apparatus can work to a maximum temperature of about 1,600 deg. C.

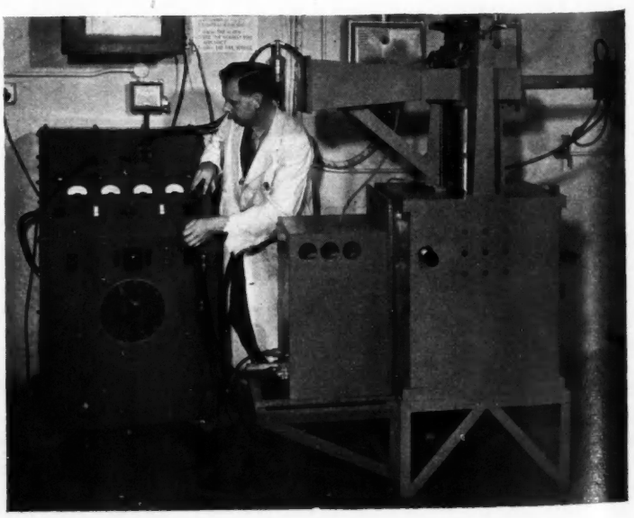
One of the Association's activities which is only two years old, but which has proved extremely successful, is the carrying out of research in foundries belonging to member firms, and 498 visits have been made.

Work in co-operation with other research organisations is also undertaken. At present, for example, the British Cast Iron Research Association is carrying out work on cast-iron propellers, in conjunction with the British Shipbuilding Research Association. This work covers casting procedure, composition, and investigation of the rapid pitting which sometimes occurs at propeller tips. The research, which is still proceeding, has included field investigation of propellers which have been in service, determination of mechanical properties, investigation of compositions, structures and protective coatings likely to resist cavitation erosion, corrosion of cast iron in moving seawater, and several other aspects of the problem.

The results of the Association's research work are made available by the publication, six times per annum, of a journal. The Association also deals with numerous enquiries and among problems submitted have been the gating and feeding of complicated hydraulic castings; cracking, both in light castings and in heavy rolls; the obtaining of high mechanical properties in very heavy sections; and the brazing of cast iron.



A direct-reading spectrographic quantometer, calibrated to deal with ten elements.



For testing moulding and core sands at high temperatures and under load, a special v.h.f. heater has been developed.

Fig. 1 The Tungatinah Power Station (left background) during the course of construction. The Tarraleah Station (already operating) is in the foreground.

TUNGATINAH POWER STATION

DEVELOPMENT OF HYDRO-ELECTRIC SCHEMES IN TASMANIA

Tasmania, an island possessing great mineral wealth, particularly in the western section, has almost unlimited water power. Its lakes and rivers afford potential power approaching 3½ million h.p., reckoned at 50 per cent. load factor. Since the population of Tasmania is less than 350,000 persons, the potential power of more than 10,000 h.p. per 1,000 head of present population must rank as one of the highest in the world.

The development of water power in the island dates from 1892 when the Launceston City Council began work on the Duck Reach Scheme on the South Esk river, and on December 10, 1895, electric lighting became available in the city. Since that date, the use of water power has progressed at an ever-increasing rate, culminating in the development of the Derwent Catchment Area. This project, depicted in Fig. 2, comprises the Great Lake power development scheme which includes the Shannon and Waddamana Power Stations, and power development schemes for the Butlers Gorge, Tarraleah, Tungatinah, Lake Echo and Wayatinah power stations.

CATCHMENT AREA

It is with the first stage of the Tungatinah scheme, which includes the commissioning of Tungatinah Power Station, that this article is particularly concerned. For this station, contracts were placed by the Hydro-electric Commission of Tasmania with the British General Electric Company Pty., Limited, Australia, for five 25-MW alternators. The first set was officially switched on to the electrical network on June 30, 1953, and since then two further machines have been brought into service. The power station and its surroundings are shown in Fig. 1.

Two and a half miles upstream from the Lyell Highway (see Fig. 2) the Pine Tier Dam has been built across the Nive River to create a new lake and divert the flow through eight miles of concrete flumes and canals to the Bronte Lagoon. From there, the water is led by canals and cuts to artificial storages, Bradys Lake and Lake Binney, whence it flows into the Tungatinah Lagoon. A tunnel with a cross section of 231 sq. ft. has been driven through the hills to supply five steel penstocks each 3,200 ft. long and of maximum diameter of 90 in., which lead to the power station.

Construction of the Pine Tier Dam, which is 120 ft. high, has tapped a catchment area of 321 square miles having an average annual run-off of 590 cusecs. A weir, constructed across the Clarence River, diverts additional water to Bronte Lagoon through a wood-stave and steel pipeline, 5½ miles long and 63 in. in diameter, having a capacity of 190 cusecs. A small dam will be built later across Laughing Jack Lagoon to provide some storage for regulation of a catchment area of 48 square miles. The average flow diverted to Bronte Lagoon will be 120 cusecs.

Finally, on the completion of the second stage of the scheme, which includes the provision of storage at Lake Echo, the construction of Lake Echo Power Station and the diversion of the River Dee, a further source of water supply will be available for the Tungatinah Station. A rock and earth fill dam, 60 ft. high, is being built across the outlet from Lake Echo. This natural lake has a surface area of 11 square miles and the total storage available will be 600 square mile-ft. The headwaters of the Little Pine and Ouse Rivers will be diverted into Lake Echo and a canal, having a capacity of 800 cusecs, will lead from the lake to a steel penstock, of diameter 114 in., which will supply Lake Echo Power Station. A dam, 50 ft. high, being built across the Dee River adjacent to the Lyell Highway, will create an artificial lake below the power station, to be known as Dee Lagoon.

From here a 2¼-mile tunnel of 800 cusecs capacity will carry the water to Brady's Lake and thence to Tungatinah Power Station. The catchment area below Lake Echo to be brought into service by the dam covers 51 square miles and has an average run-off of 50 cusecs.

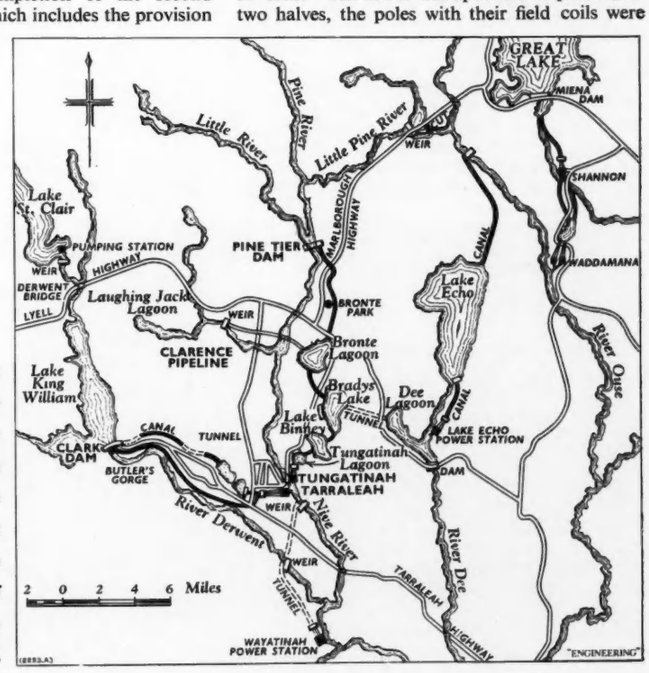


Fig. 2 The catchment areas included in the Derwent hydro-electric schemes. Tungatinah Power Station is the most recent to be put into operation. The Lake Echo section of the scheme will be the next to be carried out.

GENERATING PLANT

The generating plant consists of five alternators each rated at 25 MW (0·8 p.f.), generating at 11 kV, 3-phase, 50 cycles, and with a normal running speed of 600 r.p.m. The machines were designed and built at the Witton engineering works of the General Electric Company, Limited. Each alternator is of the vertical-shaft type with a combined thrust and guide top bearing and a bottom guide bearing, the former being supported on a bracket mounted on the frame of the alternator. Mounted above the alternator and directly coupled to it are the main exciter, pilot exciter, and permanent magnet governor alternator, the three machines being assembled to form a self-contained unit. A half-section of one of the generators is shown in Fig. 3.

The complete machine is driven from below by a directly-coupled Francis turbine of Boving manufacture rated at 35,000 h.p. and operating under a static head of 1,005 ft., the set being designed for an overspeed of 1,050 r.p.m.

In order to comply with transport requirements, the alternators, which weigh over 175 tons, were constructed in such a manner that the weight of any single part was limited to 35 tons. The stator was split and dispatched in two halves, the poles with their field coils were

removed from the magnet wheel, the exciter armatures and permanent-magnet alternator rotor formed a self-contained assembly, while the radial arms supporting the top thrust bearing housing were also dismantled and shipped separately.

The stator frame is a heavy fabricated structure of octagonal shape, built in two halves which are bolted and dowelled together. The construction of the core follows standard practice, segmental stampings being secured by dovetailed keys bolted to longitudinal ribs within the frame. For these machines a two-layer diamond-type winding is used, the insulation being of class "B" category comprising mica and micanite throughout. Six thermo-couples, embedded in the stator, enable the temperatures of the core and windings to be recorded on the remote temperature indicator which is mounted on the turbine gauge panel.

The rotor is designed for a safe overspeed of 75 per cent., i.e., 1,050 r.p.m. The shaft and coupling are forged in one piece. Twelve plates are shrunk and keyed on the shaft to form the rotor body into which the laminated poles are T-slotted and secured by taper keys. Each pole winding is subjected to heat and hydraulic pressure to form a solid coil in which risk of movement of individual turns is eliminated. Circumferential movement is prevented by duralumin wedges fitted between adjacent pole windings and secured to the rotor body. Copper rods in the pole faces are brazed into copper plates which are connected together by duralumin rings to form the squirrel cage damping winding.

Two centrifugal fans, one at each end of the rotor, circulate the cooling air through the machines, the lower fan embodying the braking ring.

The rotor is supported by a thrust and guide bearing of the Michell type which is designed to carry a total load of 270 tons, representing the weight of the rotor and the external thrust produced by the water turbine. The housing is spigoted and bolted to the thrust-bracket assembly which is bolted to the stator frame and located by tapered dowels. Doors in the housing give access to the thrust pads for maintenance purposes. The bottom guide bearing housing is centralised and located by jacking screws, no spigot being used. In order to obviate any risk of current circulating through the rotor shaft, the thrust and guide bearings are insulated from the supporting structure.

The armatures of the main and pilot exciters, the rotor of the permanent-magnet alternator for supplying power to the turbine governor motors, and the centrifugal overspeed device are mounted on a forged steel shaft to form a self-contained assembly which is solidly coupled to the main alternator shaft.

The main exciter is separately excited with a counter shunt winding, while the pilot exciter is compound wound. Initial adjustment of the field current of this machine is obtained by a shunt-field regulator.

AUXILIARY EQUIPMENT

The cooling system forms a closed air circuit in which cool air is drawn from the alternator pit and forced through the machine, the warm air being returned to the pit through a cooler which is arranged in eight sections.

With a cooling-water inlet temperature of 27 deg. C. and a rate of flow of 616 gallons per min., the complete cooler assembly will reduce the temperature of 63,000 cub. ft. of air per min. from 56 deg. C. to 35 deg. C. The capacity of each section is such that any seven of the eight units are capable of dissipating the full-load losses (approximately 700 kW).

Flow lubrication is used for the guide and thrust bearings of the alternator. Oil from a 1,000-gallon tank is circulated by a motor-driven pump through an Auto-Klean strainer and Serck oil cooler to the bearings.

Budenberg mercury-in-steel thermometers are fitted to all bearings and are connected through capillary tubing to indicating dials on the turbine gauge panel. Each thermometer has two contacts which can be adjusted independently and give an alarm if the bearing temperature reaches 68 deg. C., and operate the emergency trip circuit to shut down the set if the temperature rises to 80 deg. C.

The braking and jacking equipment was supplied by Jones Tate and Company, Limited Bradford. It comprises five rams, equally spaced and acting upon the brake ring which, as previously mentioned, is fabricated integrally with the lower ventilating fan on the magnet wheel. The top of each ram forms a flat plate which carries a heavy brake lining. Although the braking system and the jacking system are interlinked, they are operated independently of each other.

By means of the jacking system the magnet wheel can be lifted when the machine is at rest to allow an unrestricted flow of oil through the thrust bearing prior to starting and also to enable essential maintenance work to be undertaken. For jacking, high oil pressures are required and these are obtained from a Towler Brothers Electraulic high-speed multi-ram pump which delivers oil at a pressure of 1,650 lb. per square inch.

The plant is operated from the turbine gauge panels on which are mounted all the controllers, temperature indicators and alarms.

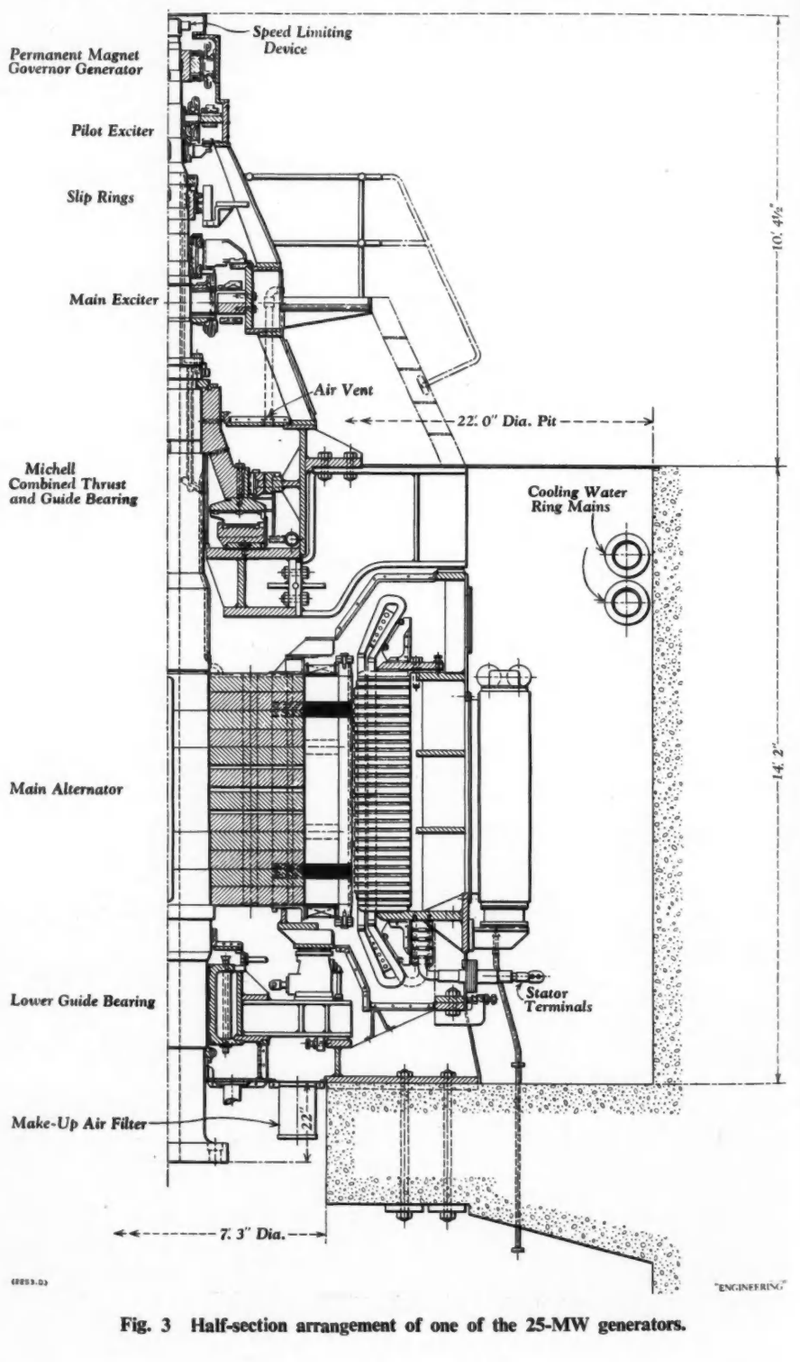


Fig. 3 Half-section arrangement of one of the 25-MW generators.

The hearth of the heat-treatment furnace is of heat-resisting steel, in the form of interlocking plates which allow for expansion and prevent heat-buckling. Town gas is used for producing a controlled atmosphere.

STANDARDISED ELECTRIC HEAT-TREATMENT FURNACE

Birlec, Limited, Tyburn-road, Erdington, Birmingham, 24, have introduced a new range of electric heat-treatment furnaces of standardised design. The furnace is available at present in two sizes, of 30 kW and 20 kW nominal rating, to work off a standard three-phase electricity supply. It is designed for a wide range of duties, including hardening, tempering, annealing, normalising, nitriding and pack-carburising, and will operate in the temperature range 700 deg. C. to 1,050 deg. C. The clear space available inside the furnace is 3 ft. deep by 1 ft. 8½ in. wide by 12 in. high in the case of the 30-kW size, and 2 ft. deep by 1 ft. 2¼ in. wide by 9 in. high in the 20-kW model. Both models are available with or without controlled atmosphere as required. A larger addition to the range is under consideration.

ENCLOSED DESIGN

The furnace is basically similar to others made by Birlec, Limited, for the same duties for several years, but incorporates a number of new features, including a light steel-plate casing enclosing the door gear and other parts which were previously exposed. The external appearance of the furnace is, as a result, clean and pleasing. The casing also makes it possible to provide an attractive painted finish, which has hitherto not been usual on furnaces.

The front of the furnace slopes backwards slightly, and the door lifts outwards and upwards to give full access to the hearth. The sloping front helps to ensure that the door seats firmly, and so to provide an effective seal against heat and atmosphere losses. A concealed counterbalance is provided for the door, which is controlled by a hand-lever at the side of the furnace.

Heating is by heavy-section tape elements of nickel-chromium heat-resisting alloy, arranged in the furnace roof and side walls, and beneath the hearth plate. Slotted bricks are used for mounting the elements, which can thus be removed separately without disturbing any of the brickwork. The furnace hearth in the 30-kW size is of a new design, comprising a number of small interlocking plates of heat-resisting steel. Provision is made at the interlocking joints for expansion, and it is claimed that buckling of the hearth through heat-distortion is practically eliminated. In the 20-kW furnace, which is of smaller dimensions, the jointed hearth plate is not fitted; the hearth in this case consists of two single plates butted loosely together.

CONTROLLED ATMOSPHERE

Town gas is used for the production of a controlled atmosphere in the furnace. A mixture of town gas and air under pressure is admitted through a slit in front of the hearth immediately behind the door, the gas being taken directly from the main, and the necessary pressure being induced by the air feed. Opening the door automatically adjusts the air/gas mixture, to provide a straight curtain of flame across the full width of the opening. A feature of the design is that a small removable plug at the side of the casing gives access to the combustion chamber, so that cleaning can be carried out at any time, without disturbing the brickwork. If a controlled atmosphere is not required, the gas curtain equipment can be omitted; in this case the door is fitted with heating elements on the inner face to compensate for heat losses at the entrance to the work chamber.

The furnace has built-in control equipment, with a detachable-key type control, indicating pyrometer, and manometers to indicate gas and air pressures mounted on a steel panel at the side of the casing. The remainder of the electrical equipment, including switchgear and transformer, is mounted inside the casing behind removable panels.

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VALVE ROCKER GRINDING MACHINE

Cam Face Ground in One Movement

The need for quantity production and the shape of the valve rocker used in the modern overhead-valve internal-combustion engines present a grinding problem which can be solved by the use of a special-purpose machine. The component itself is usually a casting with a chilled pad or a stamping case-hardened on this surface to Rockwell C55. The face of the pad, which actuates the valves, often has a form which is made up of a combination of small radii with a much larger radius at right angles to it. In the general design of rocker, shown in Fig. 1, the smaller radii usually vary from 0·4 in. to 0·5 in., while the larger is 24 in. or 30 in.

For grinding such rockers, the machine shown in Fig. 2 incorporating a special work-holding fixture has been introduced by Arthur Scrivener, Limited, Tyburn-road, Birmingham. It has two grinding wheels 20 in. in diameter by 1¼ in. wide, which run at 1,140 r.p.m., and are mounted a few inches apart. In front of the wheels is the fixture. It consists primarily of a work-holding arm pivoted at the end farthest from the grinding wheel. Two rockers are held in position at the end of the arm nearest the wheels by hydraulically-operated clamps.

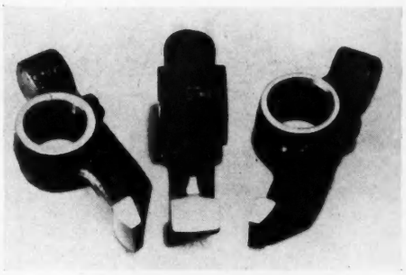

Fig. 1 Conventional overhead-valve rockers for high-speed internal-combustion engines.

The arm is raised and lowered hydraulically so that each rocker moves down and up through an arc. The rockers make contact with the grinding wheels as they pass the horizontal point in the arm's travel. This movement produces the large radius. The smaller radii are obtained in a simple manner. Before grinding commences a groove is cut in the periphery of the wheel and this is dressed by a standard form truing attachment to give the desired contour.

The downward movement of the arm applies the roughing cut and the upward return movement the finishing cut. To produce a slight advance at the work head between the roughing and finishing cuts the makers' controlled-cycle mechanism incorporated in the machine is used. A production rate of about 700 pieces per hour has been achieved on the machine at a stock removal rate of 0·005 in. to 0·010 in., which is about the normal depth of grinding.

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ELECTRICALLY-OPERATED DISPLAY STAND

An eight-page book display stand designed to show a new illustration every 6 seconds automatically has been produced by Universal Screen Services, 65 Kensal-road, London, W.10. Each page takes a photograph or advertisement 10 in. long by 8 in. wide, thus enabling 16 different illustrations, or samples of materials, to be shown. The unit is operated by a small electric motor from alternating-current supplies at 200/250 volts or 110 volts.

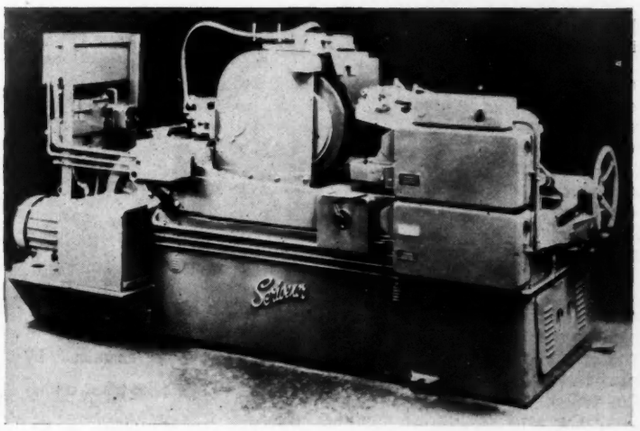


Fig. 2 Two grinding wheels mounted opposite a pivoted work-holding head enable this machine to hold and grind two valve rockers in a double pass.

The Voith water "tractor" can move in any direction – forward, astern or sideways (as shown here) – and can turn practically in its own length.

WATER "TRACTOR" WITH VOITH-SCHNEIDER PROPULSION

EXCEPTIONAL MANŒUVRABILITY

The Bee-type Voith water "tractor," designed in Germany by J. M. Voith, Heidenheim, was demonstrated recently at the Victoria Docks, London, E.16, by courtesy of William Cory and Son, Limited, 117 Fenchurch-street, London, E.C.3. This all-purpose tug is fitted with the Voith-Schneider propeller and is designed to take full advantage of this device, which was described in ENGINEERING, vol. 148, page 315 (1939) by Captain E. C. Goldsworthy. The propeller is installed directly below the cabin, slightly forward of amidships, and is capable of moving the tractor in any direction. Thus the tractor can move bodily to port or starboard as well as ahead and astern, and this it does readily, even when barges are lashed on each side, responding almost instantaneously to any change of direction.

The vessel is only 33 ft. long, with a beam of 9 ft. 10 in., a draught of 4 ft. 7 in. and a displacement of approximately 12 tons. The draught of the hull itself is only 2 ft., the additional 2 ft. 7 in. being required by the propeller and after fin. It is normally powered by a 115 brake horse-power engine. On a trial run last year the craft gave a tow-line standing pull of 1·3 tons per 100 h.p. With a ship speed of 9 m.p.h. it stopped in 16 ft., and also made a full rotation of 360 deg. in slightly more than its own length, by a sideways movement, in 14 seconds. The fuel-oil consumption with the 115 brake horse-power engine fitted was 0·4 lb. per horse-power per hour.

The fact that the propelling unit is forward avoids a heeling movement when towing and ensures stability between the thrust of the propeller and tow-line pull. For this reason, there is no necessity for a large hull of the kind used on a normal tug. Some idea of the difference in the hull can be obtained from the illustration of the vessel on this page.

The engine is mounted in a cockpit astern and the drive taken forward to the propeller. Briefly, the propeller consists of a number of vertical blades of aerofoil section projecting from the bottom of the hull. They rotate around a circle about a vertical axis. The blades are continually feathered as they rotate, by a mechanism within the hull, so that during the first half of a turn they push the water back, producing a forward thrust, then turn to repeat this process in the second half of the revolution. No thrust is produced as they pass the points between each half of a revolution.

Manœuvring is performed by two controls in the cabin: a hand lever and a motor-car type of steering wheel. The lever adjusts the magnitude of the thrust from full ahead through stop (neutral) to full astern, while the hand-wheel, which can be operated simultaneously, turns the ship when moving ahead or astern and also produces movement, within the boat's own length, to port or starboard. The type of propeller used eliminates the need for a rudder, tail-shaft and thrust bearing. Furthermore, there is no need to reverse the direction of rotation of the propeller; thus the engine is able to perform at nearly constant r.p.m.

Apart from the tractor described, two larger models are being built. One is the Hornet, which is fitted with two Voith-Schneider propellers and driven by two Diesel engines, each of up to 150 brake horse-power. Its length is 44 ft., beam 14 ft., draught 5 ft. 3 in., and displacement about 25 tons. The other is the Sea-type, driven by two 300 to 400 brake horse-power Diesel engines, which has a length of 65 ft. 6 in., a beam of 20 ft. 4 in. and a draught of 8 ft. 10 in. Its displacement is 95 tons and it is suitable for handling the largest of sea-going vessels.

There is no doubt that the great advantage of these craft is their small overall size and extreme manœuvrability. They can be operated by one man and can handle large numbers of barges or work other vessels in much less time than that taken by the conventional tug. Also, the tractor can be used as a pusher should the need arise.

The Bee-type tractor demonstrated its capacity for handling a large train of barges at the Royal Victoria Dock on Wednesday, June 30. Some 42 barges were lying in tiers of three alongside the quay ready to go out of the western lock. The tractor was made fast between two of the leading craft and with an athwartships thrust it moved the forward end of the train away from the quay and towed the complete train to the lock entrance. The total deadweight of the 42 barges was approximately 6,000 tons and the approximate total displacement 8,500 tons.

At the lock entrance the train was cut after the first 12 barges – the maximum number possible in the lock area. These were then moved into the lock and brought to a standstill with the precautionary check ropes from the stern line of barges. Finally, the barges were delivered to tugs waiting in the river.

* * *

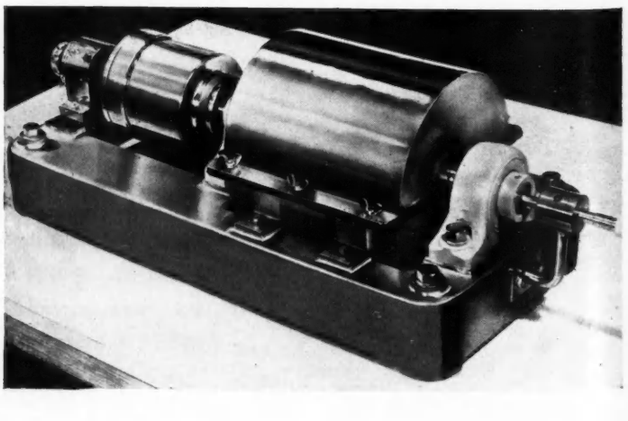
PILOT PLANT FOR CENTRIFUGING SLURRIES

For Testing Samples or for Small-Scale Production

A new pilot-plant centrifuge has been developed by Sharples Centrifuges Limited, Tower House, Woodchester, Stroud, Gloucestershire, for assessing samples of slurry to be handled in their full-scale Sharples P-14 Super-D-Canter. The latter machine is widely used in industry for the recovery of solids from slurries by centrifuging, and for classifying solid particles according to particle size. It has a feed rate of 300-2,500 gallons per hour, depending on the application.

In applying the P-14 Super-D-Canter to new applications, however, difficulties were encountered. With this type of centrifuge the standard laboratory simulation tests are not very satisfactory owing to the combined settling and "scrolling" action in the centrifuge bowl. A full-scale test had frequently to be carried out on the P-14 machine, using quantities of up to 1,000 gallons of feed for the test. This was expensive, and in the case of new processes frequently impossible since only small quantities of the materials might be available for test at the time when a decision had to be reached on the separation equipment.

To overcome this difficulty, the Sharples company have produced a new pilot-plant Super-D-Canter known as the Model P-4. This machine



Small samples of slurry can be examined by this pilot-plant centrifuge.

has an average feed capacity of 1 gallon per minute and a maximum feed rate of up to 2½ gallons per minute, and in consequence test work can now be carried out on as little as 5 gallons of slurry. The Sharples testing laboratories at Stroud can therefore now examine samples of slurry of as little as 5 gallons and, since the mode of operation of the P-4 is identical to that of the full-size P-14 machine, can give a firm prediction of capacity and performance of the same materials in the full-size industrial P-14 series Super-D-Canter.

Apart from the application of the P-4 machine to testing the separation characteristics of slurries for scaling up to full-size plant, it can also be used for small-scale production work, for pilot-plant operation, and as a general laboratory tool, in laboratories where slurries have frequently to be separated as part of routine analysis procedure, or as part of a research programme.

The actual capacity of the P-4 Super-D-Canter varies with the particle-size distribution of the solids, the nature of the liquid, and the degree of separation required, but typical capacities are, slurry containing 5 per cent. solids by volume, feed rate 2½ gallons per minute; slurry containing 20 per cent. solids by volume, feed rate 1 gallon per minute.

The Sharples P-4 Super-D-Canter is fabricated in stainless steel and consists of a conical bowl, rotated in a clockwise direction, viewed from the feed end, about a horizontal axis, in which the slurry is subjected to centrifugal force. The drive is through a V-belt from an outboard motor. A screw conveyor, rotated through a speed-reduction gearbox about the same axis as the bowl but at a lower r.p.m., moves the sedimented solids to one end of the bowl for discharge from ports. The discharges of solids from one end and liquid from the other end are collected in a casing and diverted in separate streams away from the machine.

Provision is made to feed the slurry into the bowl through an axial-feed tube. Centrifugal force separates liquid from the slurry, and this liquid overflows through apertures in the " plate dam." The relative motion between the conveyor and the bowl advances the separated solids to the opposite end, and the solids are delivered into the casing.

At the end of the gearbox is an adjustable spring-loaded clutch assembly connected to the pinion shaft of the gearbox so that tension can be applied to offset the torque engendered by the conveyor, by holding the pinion shaft stationary. Attached to the pinion shaft, between the clutch and the gearbox, is the clutch finger. Any tendency of this finger to rotate indicates that the pinion shaft is rotating, and calls for a greater tension on the clutch.

The bowl, which is of the conical type, consists of a shell to which are attached two hubs. Horizontal extensions of these hubs are mounted in plummer blocks. Inside the bowl is the conveyor. At each end of the conveyor is an insert into which is pressed a bushing which rides on the bowl hub. The joints between the conveyor and the hubs have seals to exclude the slurry from the bearing surfaces. In addition, there is a thrust ball bearing, which is grease packed.

The centrifugal force of a centrifuge bowl is a function of the product of the bowl diameter and the square of the rotational speed. Since the diameter of the Super-D-Canter is fixed, the centrifugal force of the machine can be varied only by changing the rotational speed of the bowl. Normal operating speed is 4,000 r.p.m., but the unit may be, if desired, operated at speeds up to 6,000 r.p.m. The approximate overall dimensions of the machine are length 32 in., width 30 in., and height 10 in.

PREVENTING POLLUTION

REPORT ON WORK CARRIED OUT DURING 1953

Is anything being done to prevent the atmospheric pollution which has been brought so much to public notice by the smogs of recent years? That question is frequently posed at the present time. Part of the answer to the question is contained in the reports of the Chief Alkali Inspectors that have just been published.* These (one for England and Wales, and one for Scotland) cover the year 1953 and make an interesting record of the safeguards which are imposed on works where the emission of toxic or offensive gases or dust and grit is possible. On the whole, wherever complaints have been made and considered justified, the owners of the premises have co-operated willingly in actions to remove the source of the trouble. Where infringements of the Acts have been committed, the cause was usually accidental, as when the wall of a muffle cracked and allowed hydrochloric acid gas to escape up the chimney. In those cases where no definite figures are laid down and the decision rests with the discretion of the inspector, owners and managers have proved equally co-operative.

TIP FIRES

The first few pages of the report deal with the handling of colliery spoil and refuse to minimise the risk of spoil-bank fires. Seven suggestions are put forward for dealing with new banks, including crushing, consolidating and underground stowage, which last would be ideal from many points of view except cost. Not so much can be done with old banks, but records show that the total number of banks in the lowest category (those emitting much smoke or fume) has been reduced by three since 1952 and by six since 1951, although the total number of banks registered has remained the same (473). Slightly more than half the banks showed no smoke or fume, and only 23 were included in the lowest class. Recommendations have been made in each case for controlling the combustion. In all, 106 visits were made in this connection.

POWER STATIONS

Under the heading " Unregistered Processes," are included 376 visits to power stations, gas works, industrial furnaces, metallurgical processes and some chemical works. Brief notes are given of many of the visits and of the recommendations made. With regard to power station complaints, emission of smoke and grit from one was so bad that a Question was put in Parliament concerning it, and discussions are in progress at a high level. At another, the grit collected in the arresters was being used to reclaim water-logged ground; the topsoil was removed, a 12-ft. layer of grit put down and 18-in. of topsoil replaced. Land so reclaimed has proved suitable for grazing and also for crop raising.

Detail figures are given for Battersea power station, where investigations have been made on the efficiency of the gas-cleaning plant. For a considerable part of the year, some of the plant was under repair and consequently the proportion of gas washed only averaged 52 per cent. over the year. The estimated total weight of sulphur in the coal used was 7,660 tons, of which only 3,120 tons were retained by the cleaners and in the ash. Thus, some 4,540 tons of sulphur were liberated in the atmosphere, mainly in the form of oxides in very dilute concentration. At Bankside " B," a new station designed for oil fuel with a maximum sulphur content of 4 per cent., the washing plant is designed to remove 95 per cent. of the oxides of sulphur from the waste gases. Figures for the six months that the plant has been operating show that the estimated efficiency was actually 97·5 per cent. This means that only 21 tons of sulphur escaped as against the 822 tons that were retained.

It is impossible to do more than pass over the notes recorded concerning all the visits paid by the inspectors to various other premises where there had been complaints concerning fumes or dust. (All premises visited, other than the two power stations already mentioned where experimental work was being carried out, are referred to by number only.)

In more than one instance, the cost of the equipment needed would be considerable, and might be a real embarrassment to a small company. Both the inspectors and the local authority take a sympathetic view of these cases, as also where the plant has reached the end of its economic life but has to be run to meet the demand for the product.

TOXIC VAPOURS

Two toxic substances encountered among the non-registered processes which have given rise to some complaint are fluorine and selenium. One farm, which is almost surrounded by brickworks, potteries and a frit factory, all of which are potential sources of fluorine emission, has been taken over by the Ministry of Agriculture and Fisheries for general study purposes. A herd of pedigree cattle on this farm had previously been found to be suffering from fluorosis. A reliable method of fluorine determination in vegetation is required as a standard. With selenium also, figures for toxicity are somewhat contradictory, but it is suggested that American standards should be adopted for the present. At one place, as a precautionary measure, allotment holders were warned not to eat any of the produce of allotments which appeared to be contaminated, and all vegetable matter was removed and buried in a tip to prevent re-cycling of the selenium. Here, again, the company concerned are giving full co-operation with the preventive measures.

Included among the " Registered Works " are alkali and acid works, cement works and most chemical works. The enormous demand for cement during recent years has caused all plant to work to capacity and consequently the smoke and dust emission has tended to increase. Complaints have continued steadily along Thames-side, and the problem there is considered to be possibly the most intractable facing the Department. Climatic conditions during the first part of 1953 made matters worse. However, it appears that some improvement has been achieved and, with materials being in better supply, the shut-down periods of cleaning plant have been reduced. As an example of the cost involved in providing improved dust arrestment, the installation of four precipitators at one works, with the necessary reorganisation of layout, would cost over £500,000.

Visits to registered works during the year numbered 3,452 in England and Wales and 189 in Scotland; 2,062 analyses of samples were made. Appendices are attached to both reports giving statistics relating to visits made and to production during the year.

* Ninetieth Annual Report on Alkali, &c. Works, by the Chief Inspectors, 1953. H.M. Stationery Office, Kingsway, London, W.C.2. (2*s.* 6*d.*)

This weight, or load, indicator measures the tension in the wire rope to which it is attached. Measurement is by means of three rollers which deflect the rope from its natural straight line.

LOAD INDICATOR FOR WIRE ROPES

For Portable Oil-Derrick Rigs

A dead-weight indicator designed primarily for use on portable oil-derrick rigs, but also suitable for other applications in which measurements of rope tension are required, has been developed by the B. and A. Engineering Company, Limited, 50 Pall Mall, London, S.W.1. Known as the model 4/40, this instrument is built to measure loads up to 25,000 lb. in ½-in. or ⅝-in. diameter four-part rope systems but can readily be adapted for other systems or for recording greater loads. Its action depends on a deflection imposed on the rope by three rollers and the makers believe that, although similar indicators are produced in the United States, it is the first instrument of its kind to be made in this country.

As shown in the illustration, the indicator incorporates a dial calibrated in steps of 1,000 lb., but other scales can be fitted if necessary. In addition to the indicating needle, the dial carries an adjustable pointer, which may be set to any desired drill penetration load, thus serving as a guide when the rig is operated, with the main hook load relieved. On recent versions of the indicator, the front rim of the dial casting is machine finished and the screws are countersunk flush with the surface. Moreover, the dial is subdivided into units of 500 lb. The standard model has a working range from zero to 25,000 lb., but an overload margin up to 40,000 lb. is provided.

REMOTE INDICATION

In place of the dial, a transmitter can be fitted; this unit operates in conjunction with a remote electrical load indicator which can be mounted in any convenient position. In both forms of the instrument, the action involves three freely rotating pulleys which impose a deflection on the rope and thus communicate the tension to a hydraulic cell. The cell, which is completely enclosed and sealed, includes a special temperature-compensation unit and has no moving parts.

The indicator, which weighs 35 lb., is 21 in. in height, 7 in. wide and 9 in. from front to rear, and the dial face is 6 in. in diameter. It is a compact unit and easily secured in position by means of a clamp which is fixed to the dead-line rope. The standard model may be adjusted for use with either ½-in. or ⅝-in. diameter wire ropes.

The method of transmitting the load is unaffected by rope deformation caused by over-tightening of the clamp and no frictional losses are incurred on load-bearing parts. The gauge incorporates a shock and vibration damper, and a light set inside the casing illuminates the dial.

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LOW-VOLTAGE SOLDERING IRON

A low-voltage soldering iron has been introduced by Scope Laboratories of Melbourne, Australia, which, it is claimed, has several useful features. Weighing only 3½ oz., it is rated at 100 watts but is only heated when soldering is actually being done. The heating circuit is completed by sliding a spring-loaded ring along the handle, which brings the heating element into contact with the rear of the bit. With a standard ¼ in. diameter copper bit, the heating time is 6 seconds when a 4-volt supply is used. The iron is suitable for any supply between 2 and 6 volts, either alternating or direct current, and the heating time varies accordingly.

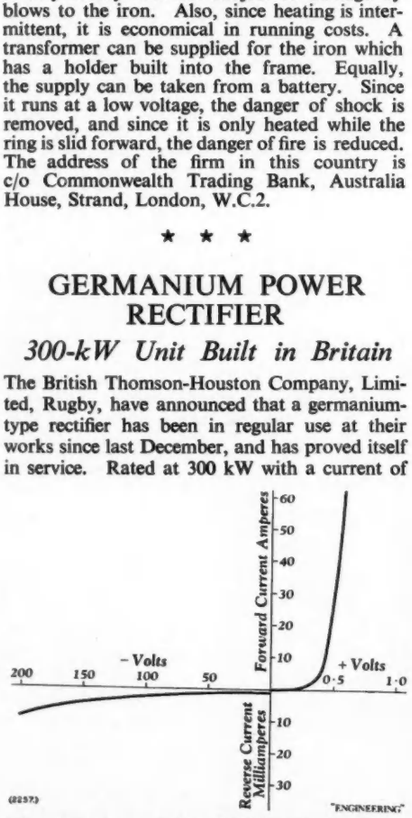
Both the bit and the element are screwed in position and both can be replaced when worn. Wear on the bit is small, however, as it is only kept hot while actually in use. The element is very sturdy and not subject to damage by blows to the iron. Also, since heating is intermittent, it is economical in running costs. A transformer can be supplied for the iron which has a holder built into the frame. Equally, the supply can be taken from a battery. Since it runs at a low voltage, the danger of shock is removed, and since it is only heated while the ring is slid forward, the danger of fire is reduced. The address of the firm in this country is c/o Commonwealth Trading Bank, Australia House, Strand, London, W.C.2.

★ ★ ★

GERMANIUM POWER RECTIFIER

300-kW Unit Built in Britain

The British Thomson-Houston Company, Limited, Rugby, have announced that a germanium-type rectifier has been in regular use at their works since last December, and has proved itself in service. Rated at 300 kW with a current of 1,100 amperes, it is believed to be the first application of germanium for power rectification in this country.



The voltage/current characteristics of a 50-ampere germanium rectifier unit.

The rectifier is built up from several units, housed in a ventilated steel cabinet. It operates at approximately 270 volts, and has been used with an electrolyser with loads varying up to its maximum rating. During the six months operation, conversion efficiency has been 98·5 per cent. The diagram shows the characteristics of a 50-ampere unit (on which the large rectifier is based) and it will be seen that the voltage drop is less than 1 volt at full load.

It is hoped that future units, which are now being developed, will have an even higher efficiency than this prototype model. During the coming year, installations will be made to try the rectifiers under more arduous conditions. When these have been completed, the question of quantity production will be considered.

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This meter weighs only 6 oz. and will measure non-ferrous layers up to 0·03 in. thick on a ferrous base.

MEASURING LAYER THICKNESSES

A meter for measuring the thickness of non-ferrous layers on ferrous material is being produced by the General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2. The complete instrument is shown in the illustration; it measures 3½ in. by 2¼ in. by 1¼ in. and weighs 6 oz. The principle of operation is that of a reluctometer of the moving-iron type. The moving iron is mounted at the axis of a permanent magnet, one end of which projects through the case at the end opposite to the scale. The projecting end of the magnet is fitted with a spherical hardened-steel tip. When this tip is placed on a ferrous plate the flux distribution is upset and the moving iron, which is spring-loaded, takes up a new position to restore equilibrium. Since the zero is partially suppressed, small, non-magnetic layers between the steel tip and the base cause different deflections so that the instrument can be calibrated directly in thicknesses.

In use, the zero is set by placing the instrument on an uncoated piece of the base steel and adjusting the pointer with the large knob. When adjusted, this can be locked. The setting can be checked by inserting known thicknesses of paper or celluloid between the tip and the base. The base materials on which it can be used can be of any ferrous type as long as the permeability lies between 200 and 8,000. The maximum layer thickness that can be measured is 0·03 in.

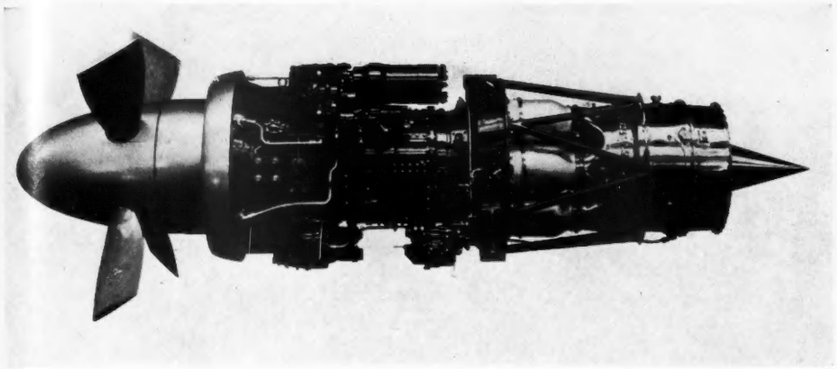

Fig. 1 The Napier Eland, a single-shaft propeller-turbine engine developing 3,000 e.h.p. for a net dry weight of 1,575 lb. A derivative of the Eland is to power the Fairey Rotodyne helicopter.

THE "ELAND" TURBO-PROPELLER ENGINE

Details of the design of the Eland propeller turbine engine have now been released by the constructors, D. Napier and Son, Limited, Acton Vale, London, W.3. The Eland (Fig. 1), a derivative of which is to power the Fairey Rotodyne helicopter, develops at take-off 3,000 effective horse-power for a net dry weight of 1,575 lb. and a frontal area of 7·1 sq. ft., with a corresponding specific fuel consumption of 0·624 lb. per effective horse-power per hour. The fuel economy and low specific weight of the Eland are the result of intensive research on the aerodynamics of compressors, turbines and ducting and on mechanical problems of blade vibration and reduction-gear design. The makers also claim that the engine has notably good response characteristics, with freedom from surge, and a gearbox of high efficiency and low noise level.

The performance of the Eland, at sea-level and at 30,000 ft. in standard atmosphere, is shown in Fig. 2, which gives curves of equivalent horse-power and specific fuel consumption plotted against aircraft speed for various engine speeds – the maximum being 12,500 r.p.m. for take-off and "operational necessity." The dimensions and general particulars of the engine are as follows: maximum diameter, 36$\frac{1}{16}$ in.; length, from the front of the propeller shaft to the end of the turbine-exit tail cone, 122$\frac{1}{4}$ in.; weight, with starter and propeller governor, 1,661 lb.; weight of jet pipe, 7·6 lb. per ft. run. The engine will run on wide-cut gasoline or on kerosine. Designed for a four-blade single-rotation propeller of diameter 12 ft. to 16 ft., four alternative gear ratios are available – 0·0714 to 1, 0·0838 to 1, 0·0912 to 1, or 0·0972 to 1.

FOUR MAIN ASSEMBLIES

The Napier Eland is a propeller-turbine aero engine designed for use with a single-rotation constant-speed propeller, the thrust of which is augmented by thrust from the jet. The engine, which provides a straight-through flow path, consists of a ten-stage axial-flow compressor delivering air to six combustion chambers in which fuel is atomised and burned continuously; the combustion products are delivered to a three-stage turbine and expelled to atmosphere through a propelling nozzle. The compressor and turbine are mounted co-axially and the propeller is driven through a reduction gear. Control of the engine is effected through an inter-connected fuel-metering unit and propeller governor, operated by a single lever. Automatic compensation is provided for changes in forward speed and ambient temperature and pressure conditions.

In the mechanical design of the engine particular attention has been given to the requirements of servicing and overhaul. The engine is divided into four major assemblies comprising reduction gear, compressor, combustion system and turbine. Each major assembly can be replaced separately so that, for example, when the turbine is removed the reduction gear, compressor and combustion system need not be disturbed. The combustion chamber and burners are separately removable for inspection or replacement, and free access is available to all engine accessories.

COMPOUND EPICYCLIC REDUCTION GEAR

The low noise level and high mechanical efficiency of the reduction gear result from the use of a compound-layshaft epicyclic gear train which incorporates a hydraulic torquemeter (Fig. 3). The gearing is not mechanically fixed to the casing and this, together with other self-centring devices, reduces vibration to a minimum and considerably improves transmission. A magnesium casting houses the reduction gear and incorporates the air intake.

From the compressor, the drive forward is imparted through a quill shaft to a high-speed input pinion supported at the rear end by a ball bearing, and, at the front, by a roller bearing. The pinion drives three planet gears having integral layshafts, each mounted on two roller bearings and carrying a planet pinion meshed with the internal annulus gear.

The combined planet gear and layshaft assembly is carried on roller bearings in the two halves of a carrier which is integral with the propeller shaft. The carrier is supported at the front by a roller bearing, and, at the rear, by a ball and roller bearing in the reduction gear casing. The ball bearing absorbs the propeller thrust.

Oil is delivered to the propeller hub through a feed in the propeller shaft and a transfer bearing mounted in the nose piece of the casing on rubber rings. The rings act as an oil seal and, in addition, prevent any load from being taken by the transfer bearing instead of the roller bearing.

At the rear end of the propeller shaft, a bevel gear drives the oil-pump assembly on the bottom cover; the accessories on the top cover are driven by a similar gear on the compressor shaft.

HYDRAULIC TORQUEMETER

The annulus gear forms the inner member of a hydraulic torquemeter; the outer consists of a torque ring. On the outer periphery of the annulus gear and the inner periphery of the torque ring are interposed vane-shaped members carrying sealing vanes which are spring-loaded against the annular walls between the opposite members (Fig. 4). The spaces between the vane-shaped members form alternate interconnected high-pressure and low-pressure chambers of the torquemeter and allow relative peripheral movement of the annulus gear.

During normal operation, oil is supplied by a high-pressure pump through inlet ports (Fig. 5) to the high-pressure balancing chambers, and leaks across the sides of the vanes to fill the low-pressure chambers. Drain oil escapes through exhaust ports in the torque-ring front cover to the engine sump.

As the torque increases on the annulus gear, the latter moves in relation to the torque ring, increasing the inlet-port area, and thereby increasing the oil pressure in the high-pressure chambers until the pressure is sufficient to balance the torque. Movement of the annulus gear also increases the exhaust port area to facilitate drainage of the now greater leakage of oil from the low-pressure chambers.

In the reversed-torque condition, the ports in use for normal torque are closed by the relative movement of the annulus gear and torque ring, and other ports are uncovered to reverse the functions of the high- and low-pressure chambers. A shuttle valve is incorporated in the system so that high-pressure oil is still fed to the spring-loaded by-pass valve to control the flow of oil by-passing the torquemeter.

The pressure difference between the high-pressure and low-pressure chambers varies linearly with torque. The pressure in the low-pressure chambers, however, is arranged to have its highest value at zero torque and to lie below a limiting value throughout the operating-torque range. In the event of torque failure, therefore, the signal from the low-pressure chambers will rise above the normal limit and can be used to operate a warning or safeguarding device.

Engine tests have consistently shown that

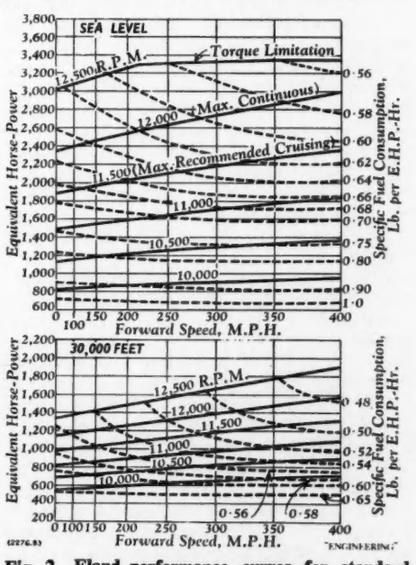

Fig. 2 Eland performance curves for standard atmosphere conditions.

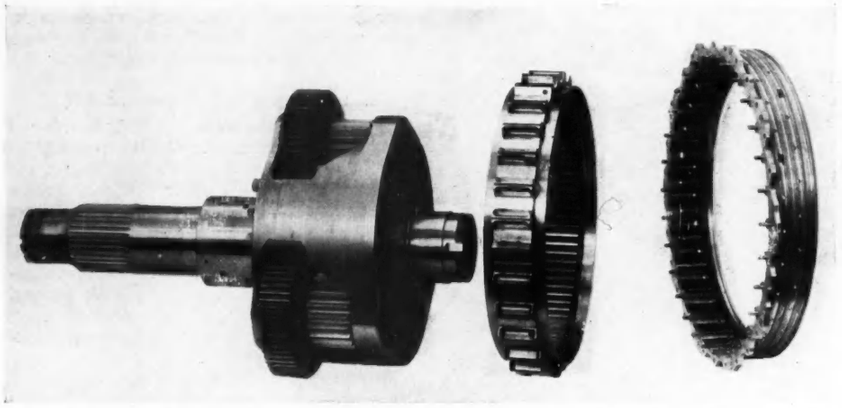

Fig. 3 Epicyclic reduction gear and hydraulic torquemeter assembly. The latter comprises the annulus gear and a torque ring surrounding it. Vane-shaped members on each are interposed to form alternate high and low oil-pressure chambers; the pressure difference provides a measure of the torque.

the accuracy of the torquemeter over the normal power range is within ± 1 per cent. of the calibrated dynamometer readings.

ANTI-ICING

Air is delivered to the compressor through an annular forward-facing intake which surrounds the reduction-gear casing immediately behind the propeller.

To give protection against icing of the intake and compressor inlet, the inner wall of the intake is heated by reduction-gear oil splashed on the casings. Jackets have been designed for the outer wall of the intake through which the reduction-gear scavenge-oil is circulated before being returned to the cooler. This scavenge oil is also circulated through the noses of six spats in the intake which house the accessory drives and other essential services. The compressor-inlet guide vanes are anti-iced by air tapped from the compressor; the air heats both leading and trailing edges of the vanes before exhausting into the main stream at the inner diameter.

TEN COMPRESSION STAGES

To obtain a minimum engine weight, the Eland compressor has been designed for a medium hub/tip ratio of 0·7, which results in a lighter reduction gearbox than would be the case if a smaller higher-speed compressor were adopted.

A design pressure ratio of 7 to 1 has been achieved at 31 lb. per second air mass-flow for the take-off rating with only ten stages of blading. The use of variable-inlet guide vanes, which are controlled by a speed-sensing servo unit, results in good engine handling and acceleration responses, which are obtained without danger of surge.

The compressor is of simple construction, comprising a disc-and-shaft rotor enclosed by two half-casings to which are bolted the stator rings (Fig. 6).

Aluminium-bronze blades are used throughout and all the rotor blades are secured by fir-tree roots to the compressor discs. These, in turn, are located over flank-fitting splines to a hollow steel rotor shaft. For stages 1 to 7, the rotor discs are of aluminium and the remainder are of steel. The stators, which are of shrouded construction for the first four stages and cantilever for the remainder, are contained in the two halves of the L51-alloy compressor casing (see Fig. 6).

A ball-and-roller bearing at the front and a roller bearing at the rear support the compressor-rotor shaft, which is connected to the turbine by a gear-type coupling. To prevent windmilling while the aircraft is on the ground, a parking brake is fitted to the rear end of the compressor shaft.

Provision is made for mounting the engine on three pads on a support plate situated at the rear of the compressor. This casting in Z.T.1 light alloy includes the diffuser, between the compressor and combustion chambers, and an internally-cast annulus into which air is bled from the diffuser for turbine cooling and cabin pressurising.

The combustion system, designed in conjunction with Joseph Lucas Limited, comprises six tubular chambers fitted with upstream injection burners. For servicing, to facilitate removal through the turbine frame each chamber is secured at either end by clamping rings.

The outer combustion chamber casings are fabricated in S.84 material and the flame tubes are in D.T.D. 703. High-energy spark-ignition plugs are provided in two of the combustion chambers from which the flame is propagated to the remainder by interconnectors. The use of upstream injection burners not only reduces the overall length of the system but gives good combustion at very high air/fuel ratios.

To achieve the maximum output from the turbine without excessive weight penalty, a three-stage reaction turbine has been designed for the Eland at an expansion ratio of 5·5 to 1, with zero swirl to minimise jet-pipe loss and turbine back-pressure.

The turbine comprises three separate bladed rotor discs mounted on a shaft (Fig. 7) and carried in a fabricated casing which contains

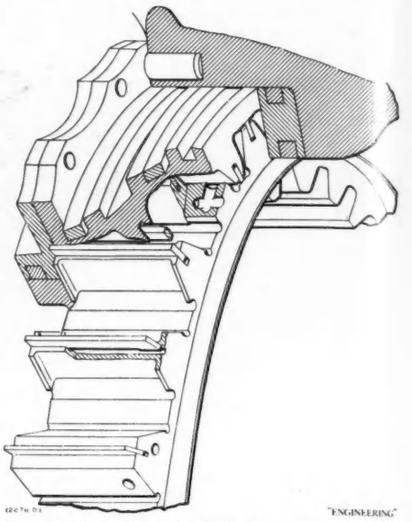

Fig. 4 Arrangement of the torquemeter sealing vanes.

the three nozzle assemblies. Of H40 material, the rotor discs are mounted over flank-fitting splines on the turbine shaft which is supported at the rear by a ball bearing and, at the front, by the gear-type coupling driving the compressor.

The combined rotor assembly (compressor and turbine) is mounted on three bearings and so arranged that the gyroscopic couples at the centre bearing are, in general, cancelled.

DIFFERENTIAL EXPANSION

The turbine-rotor blades, which are of Nimonic 90 in stage 1, and Nimonic 80A in stages 2 and 3, are secured to the discs by fir-tree roots. A limited amount of blade-tip rock is provided to allow for the differential expansion of the blades and discs, to relieve root stresses and to ensure a large measure of vibration damping.

The nozzle blades are hollow and cast in X40 material, but the first-stage blades which are secured by inner and outer rings, differ from stages two and three, which have inner and outer platforms and are bolted to the external casing. The inter-stage seal plates, which carry seals at the inner diameter and cooling scrolls on each face, are mounted from the nozzle rings by swinging links attached to several of the blade roots. This arrangement allows for differential expansion and ensures concentricity of the seals under operating conditions.

Air is bled from the compressor to cool the

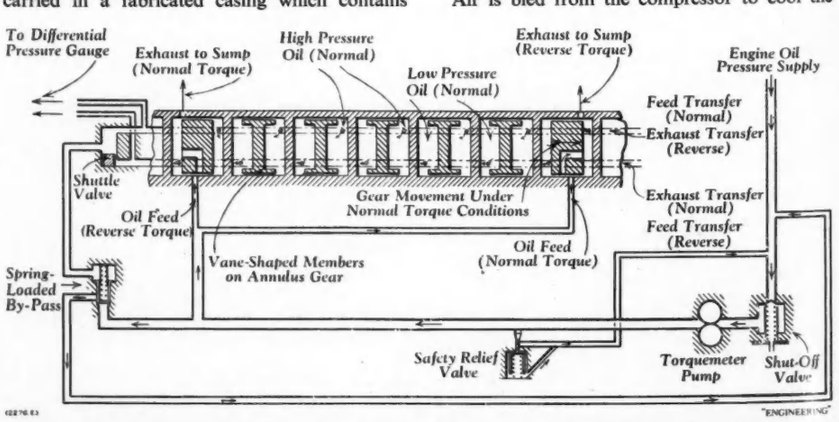

Fig. 5 The torquemeter oil circuit. In normal operation oil is supplied through a high-pressure pump to the high-pressure balancing chambers, and leaks across the side of the vanes to fill the low-pressure chambers. As the torque increases, the annulus vanes move relatively to those on the torque ring, thus increasing the high pressure until balance is obtained. A differential pressure gauge is used for indicating.

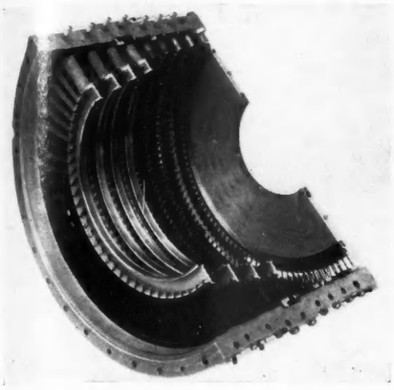

Fig. 6 Compressor half-casing and stator blades; the latter are of aluminium bronze, as are also the rotor blades.

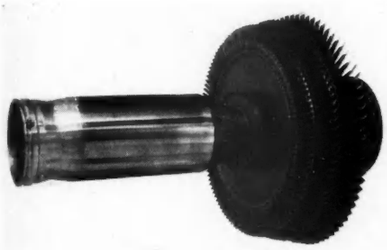

Fig. 7 The three-stage reaction turbine has an expansion ratio of 5·5 to 1, and is cooled by air bled from the compressor.

turbine-rotor discs, to supply air to the turbine and compressor balance pistons (the purpose of which is to relieve the load on the thrust bearings), to cool the compressor rear bearing and turbine bearing, and also to supply air to the inlet guide vanes to give them protection against icing.

The front face of the first-stage turbine rotor is cooled by compressor-exit air, tapped from the diffuser. The air passes through the support-plate annulus and is taken by three tubes to an annular chamber forward of the turbine. From here it flows between the front face of the disc and the front seal plate, through a scroll attached to the seal plate and exhausts across the rotor-blade roots to the trailing edge. The object of the scroll is to lengthen the path of the cooling air up the face of the disc.

Further air is tapped from stage 9 of the compressor, and passes into the hollow shaft through a static shroud. This shroud contains vanes which remove the free vortex flow which would otherwise exist in the air and thereby increases the static pressure available. The rear face of stage-1 disc, both faces of stage-2 disc and the front face of stage-3 disc are cooled by the air passing through scrolls on the inter-stage seal plates, from this supply. Air is also allowed to pass out of the rear end of the shaft in order to pressurise the turbine balance-piston chamber.

The turbine bearing and the rear face of the last-stage turbine disc are cooled in series with air taken externally through a pipe and filter from stage 4 of the compressor. Tappings from the filter supply the compressor rear bearing with cooling air, and pressurise the seals on the propeller and accessory bearings.

To heat the inlet guide vanes and to supply the compressor balance piston, air is taken forward through the hollow shaft from stage 5 of the compressor. No vortex breaker is fitted in this system as the mass flow and pressure required are relatively low.

Both the inner cone and the jet pipe, which is fitted with a propelling nozzle, are of Nimonic 75.

CONE-TYPE THRUST BEARING FOR ACCESSORY DRIVE

The engine accessories, mounted on the reduction-gear casing, are disposed in two groups around the compressor, and are readily accessible for servicing. The fuel pump, tachometer, propeller governor, synchronising alternator and an aircraft accessory-gearbox drive-shaft capable of transmitting 250 shaft horsepower, are mounted on the top of the casing and are driven by a spiral bevel gear from the front end of the compressor shaft. The design of this bevel drive is unusual in that the thrust is taken by locating cones on each gear, which help to ensure correct meshing, simplify fitting, and also avoid the need for an additional thrust bearing.

At the bottom of the casing the pressure-oil pump, torquemeter pump and scavenge pumps are all driven from the propeller shaft by spiral bevel gears.

A Rotax electric starter is mounted above the front end of the compressor, and motors the engine through the accessory-gearbox drive. Development is proceeding on alternative types of starting equipment.

SINGLE-LEVER CONTROL

The engine is controlled through a single lever operating an interconnected propeller governor and Napier fuel-metering unit which automatically compensates for changes in forward speed and ambient temperature and pressure conditions. An acceleration control is included in the unit to prevent overfuelling and surging of the engine during acceleration. The fuel-metering unit is reset by a two-position lever in the cockpit when compressor air is taken from the support plate for cabin pressurising.

A variable-datum turbine-inlet temperature control, a maximum torque-limitation device, automatic pitch-coarsening, and an inlet guide-vane control responsive to engine speed, are also fitted.

LUBRICATION

The engine is supplied with oil from a pressure pump at 80 lb. per square inch which, through a filter, delivers oil to the bearings, gears, torque-meter pump, and " Purolator " filter feeding the propeller governor. The pressure pump incorporates a relief valve which by-passes excess oil; and a static head valve, which is situated between the pump and filter, prevents flooding of the engine by oil from the tank under shut-down conditions.

The reduction gearing is lubricated by six rotating-spray-type jets mounted on the planet carrier and by impinging jets which feed the planet-shaft bearings; the high-speed pinion bearings and propeller-shaft front bearings are splash-lubricated. Calibrated jets supply oil to the compressor and turbine-shaft bearings and to the rear bearing on the propeller shaft. The accessory-drive gears and bearings are lubricated by splash oil and calibrated jets.

Engine scavenging is effected by a gear pump which returns the oil from the sump to the tank through a de-aerator, and oil-heated jackets on the intake casing. Both compressor and turbine bearings are independently scavenged by vane pumps which return the oil to the engine sump, and which ensure efficient functioning during aircraft manœuvres at all altitudes.

The reduction-gear chamber is vented through a centrifugal-impeller breather which separates the oil from the air before exhausting the air to atmosphere.

THE ROYAL SHOW

Concluded from page 93

Once more the Royal Agricultural Society of England are to be congratulated on having staged an eminently satisfactory and successful annual show. Attendance figures were considerably greater than for Blackpool, where the Show was held last year, and preliminary reports from the exhibitors indicate that there is no flagging of interest in British farm equipment and machinery. Much that was on view was either new or improved in form, and we conclude our account of the Show by describing some further examples of such machines.

SCRAPER AND CABLE-CONTROL UNIT

The exhibits on the stand of Messrs. Jack Olding and Company, Limited, Hatfield, Hertfordshire, included a new scraper and associated control unit, manufactured by Onions and Sons (Levellers), Limited. This equipment, which is illustrated in Fig. 12, on page 124, has been developed for use on building sites, road constructional work, land clearing, etc., where the scale of work and the operating conditions do not lend themselves readily to the employment of larger machines. The scraper has a struck capacity of 2·7 cubic yards and a heaped capacity of 3·6 cubic yards, and it has been designed for use with tractors having a minimum drawbar pull of 6,000 lb. It has been approved for use with the Fordson Major tractor when equipped with County full tracks and is shown attached to such a machine in the illustration. The scraper is of open-top house construction, the height of the sides being 2 ft. 9¼ in., the width 5 ft. 4 in., and the travel of the tailgate 2 ft. To give good stability, the rear wheels have been set at almost the full width of the scraper, a feature which, combined with the low centre of gravity, enables the unit to traverse rough ground in safety. The cutting blade has a width of 5 ft. 4 in. and the tailgate is sloped to achieve maximum " boiling " of the earth entering the bowl. A central-thrust type of tailgate is used, the thrust being applied by means of a wire rope in the usual manner. The pressure is evenly distributed over the full area of the tailgate which moves forward on the operating ropes, bearing only lightly on the guide pulleys. Both the ropes and rollers are located outside and to the rear of the bowl to give protection against wear and abrasive action; similarly, the tailgate return spring is totally enclosed and lies along the back of the bowl. The yoke, or swan-neck, is a robust steel fabrication designed to give ample clearance for the tyres when turning on uneven ground, the design being such that a turning circle of 15 ft. 7 in. is achieved.

The cable-control unit can be seen clearly in the illustration. It consists of a fabricated-steel body incorporating a large flange through which the unit is secured to the tractor. A top carriage, also a steel fabrication, carries the swinging fairleads which are fitted with angular-contact ball bearings that can be adjusted for wear. The rope pulleys are hardened and run on roller bearings. Friction-lined cone-type clutches are employed and the brakes, which are of the contracting-band type, are provided with spring

Fig. 12 The scraper and cable control unit shown have been designed for use with tractors having a minimum drawbar pull of 6,000 lb. The scraper has a heaped capacity of over 3½ cub. yards and can be used in locations not accessible to large earth-moving equipment.

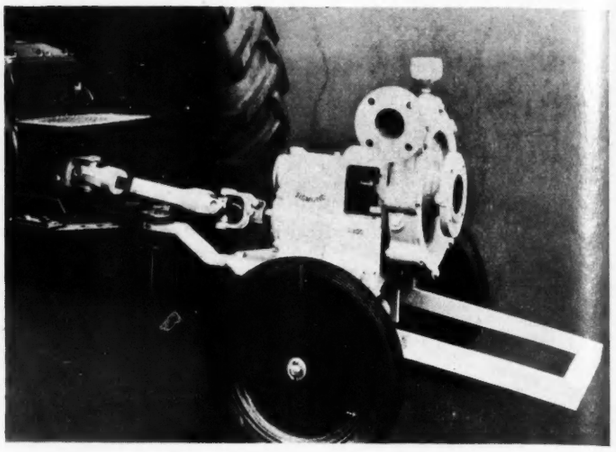

Fig. 13 This tractor-hauled and tractor-driven pump has been developed mainly for irrigation duties but can be used for general purpose work. It consists of a single-stage end-suction unit driven from the tractor power take-off through a Hardy-Spicer flexible shaft.

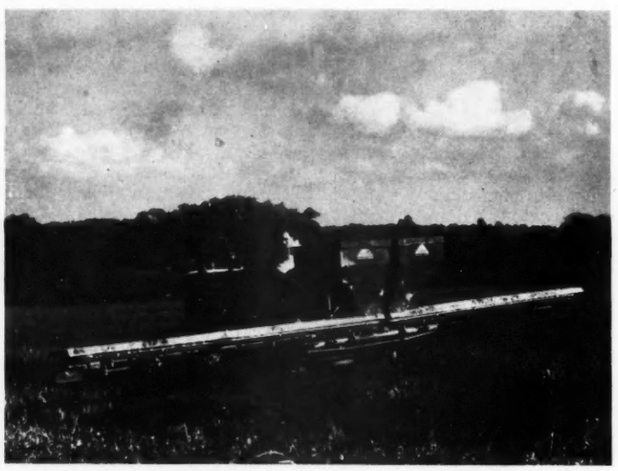

Fig. 14 The 24-ft. spread of this fertiliser distributor enables large acreages to be covered very rapidly. The rate of distribution can be varied almost indefinitely and when moving from field to field the booms can be folded forward along the side of the tractor.

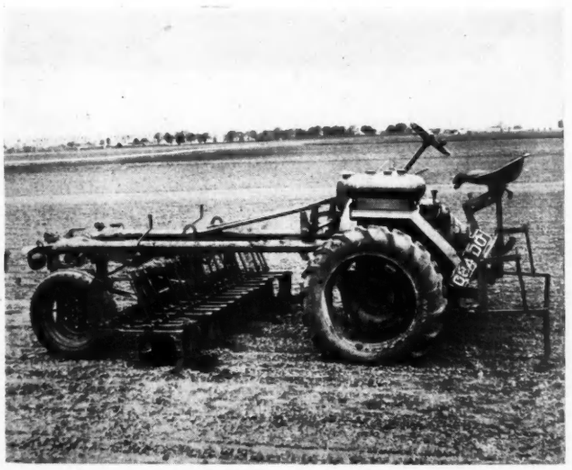

Fig. 15 Motor-driven tool carrier which can be adapted to accommodate many different implements ranging from hoes to complete harvesting equipment. A hydraulic lift is incorporated in the frame for raising and lowering the implements.

Fig. 16 Fig. 17

Figs. 16 and 17 Portable hammer mill with built-in petrol engine. It incorporates an air-recirculation system that enables the usual cyclone to be dispensed with.

Fig. 18 Tractor-mounted ditch cleaner which can be operated by the tractor driver without outside assistance. The cleaner is simple to operate and it is claimed that up to 50 yards of ditch can be cleared in half an hour.

tensioners which automatically take up the wear. They are of sufficient power to hold instantaneously the full weight of the loaded scraper. The clutches and rope drums run on ball and taper roller bearings and the design is such that all parts likely to need routine maintenance are readily accessible. The drums are 5½ in. in diameter by 3 in. long and each is capable of accommodating 100 ft. of ⅜-in. diameter cable. With the power take-off running at 500 r.p.m., the line speeds are 376 ft. per minute with a full drum and 224 ft. per minute with a bare drum. The transmission assembly consists of a set of spur gears arranged to run in an oil bath.

TRACTOR-DRIVEN IRRIGATION PUMP

The wide range of pumping and irrigation equipment being shown by Sigmund Pumps Limited, Team Valley, Gateshead, included the tractor-driven unit illustrated in Fig. 13, on page 124. Known as the Stip irrigation pump, it consists of a single-stage end-suction centrifugal pump unit mounted on a two-wheeled trolley and arranged for coupling directly to the tractor drawbar. It is driven from the tractor power take-off through a Hardy Spicer flexible shaft, connection and disconnection taking a matter of seconds. The pump casing is built integrally with a 1 to 4·25 speed-increasing gear, the gears and bearings of which operate in an oil bath. The pumping unit is of robust construction, the design having been kept as simple as possible to permit easy dismantling for maintenance and the replacement of all the wearing parts.

Three models are available, namely, the D200, the K6a and the G4, the performances of which vary, of course, according to the suction and delivery heads, speed of operation, etc. The D200 is intended for flood-irrigation work and operates at a power-take-off speed of 350 r.p.m. at which the maximum discharge is 1,600 gallons per minute against a head of 14 ft. The K6a and G4 models can operate against considerable greater heads. The G4, for example, can deliver 1,000 gallons per minute against a head of 65 ft. and the K6a 350 gallons per minute against a head of 206 ft. The high-pressure model has been designed with the needs of overhead irrigation in mind and is particularly suitable for use with the maker's Rainmaster equipment.

TRACTOR-MOUNTED FERTILISER DISTRIBUTOR

A new tractor-mounted fertiliser distributor with a spread of 24 ft. was being shown by Transplanters (Robot) Limited, Sandridge, St. Albans, Hertfordshire. This implement, the result of much development work, is illustrated in Fig. 14, on the opposite page. Actually, the 24-ft. boom is in two parts, each with its own hopper and, for transport purposes, the two sections are folded forward against the sides of the tractor.

The distributing mechanism consists of a vertically-disposed reinforced-rubber endless belt driven by a pulley situated below the hopper. The belts are provided with moulded cleats and operate in ducts, the fertiliser being carried along by the cleats and discharged through a series of adjustable slots formed in the rear wall of the ducts. The spreading rate is varied by altering the speed of the conveyor belts, which are driven through a four-speed gearbox from the tractor power take-off. In conjunction, therefore, with, say, three tractor speeds, twelve application rates are instantly available and this number can be increased by changing the input gears in the gearbox. Folding of the booms merely entails the lifting of two locking handles and swinging the two parts round, the clutches being engaged and disengaged automatically. When in the folded position, the overall width of the implement is 8 ft. 3 in.

MOTOR-DRIVEN TOOL-CARRIER

The range of machinery exhibited by H. Leverton and Company, Limited, Spalding, Lincolnshire, included several items of equipment manufactured by Heinrich Lanz, of Mannheim, Germany. One of these, namely, the Lanz Alldog tool-carrier, is illustrated in Fig. 15, opposite. It consists, basically, of an engine and transmission assembly combined with the rear axle to form a single unit. In front of this is a tubular frame which extends forwards to the leading wheels, the frame being designed to accommodate a wide variety of tools ranging from gangs of hoes to potato, beet and other crop harvesters.

A hydraulic lift is incorporated in the frame for raising and lowering frame-mounted implements and an additional hydraulic lift is available for raising rear-mounted implements. The engine is a 12-h.p. single-cylinder air-cooled two-stroke unit with a displacement of 534 cub. cm. It drives a five-speed gearbox through a single-plate clutch, the speed in bottom gear being 1·6 miles an hour and in top gear, 12·3 miles an hour.

Steering is accomplished by means of a standard Ackerman linkage through the front wheels in the normal manner and the wheel track is adjustable at both the front and the rear between the limits of 49 in. and 79 in. There are two power take-off points, one at the front and the other at the rear of the engine and, if required, power take-offs can be fitted to the front and rear wheels, the speed of the driven implements in the latter cases being exactly proportional to the speed of the tractor. Specialist implement manufacturers have, in co-operation with Lanz, developed an extensive range of equipments for use with the Alldog and these include, in addition to those already mentioned, cutter bars, planters, fertiliser distributors, seed drills, harrows, sprayers, and sweepers, to mention only a few of the machines.

PORTABLE HAMMER MILL

Four new items of equipment were being shown by Scottish Mechanical Light Industries, Limited, 42-44, Waggon-road, Ayr. One of these, a new lightweight portable hammer mill, is illustrated in Figs. 16 and 17. Known as the ScotMec "Popular," the machine is available in two forms, one with a pulley drive and the other with a built-in petrol engine, the latter model being illustrated. On the "Popular" machine, the suction effect of an outside fan is replaced by the blowing effect of fan blades incorporated in the grinding rotor. These fan blades and the associated swinging hammers can be seen in the illustration which shows the mill with the cover removed. The grinding chamber is provided with a cylindrical screen and, in operation, the flour, or meal, is blown through the screen into the bag. The air, however, is separated in the bagging attachment and recircuited by way of a duct into the centre of the grinding chamber, thus dispensing with the use of a cyclone or air-release filter. There are four sets of hammers and in accordance with usual practice, these can be reversed to give four-fold life.

Three screens are available, the meshes of which are ¼ in., ⅜ in., and ⅛ in., and the belt-driven machine can be operated by any prime mover of over 2 h.p. and up to 8 h.p., the output depending on the size of prime mover actually used. When a built-in engine is fitted, either a B.S.A. 2 h.p. or a B.S.A. 5 h.p. unit is used. The machine illustrated is fitted with the 2-h.p. engine.

DITCH CLEANER

Barford (Agricultural), Limited, Syston-lane, Belton, near Grantham, were showing a very simple but effective ditch cleaner. This unit, which is shown at work in Fig. 18, consists basically of a welded-steel lattice boom, 9 ft. 6 in. long and 3 ft. wide. One end of the boom is anchored to the rear of a tractor power lift and the other end is fitted with a swing bucket, the action of which is controlled by a wire cable attached to a lever within reach of the tractor driver. In operation, the tractor is backed up to the ditch and the bucket lowered as shown in the illustration. The tractor is then driven forward a short distance, the bucket, as a consequence, being dragged, complete with spoil, up the side of the ditch, skids fitted to the frame at the bucket end controlling the action of the cleaner up the bank. When clear of the ditch, the spoil is dumped by operating the bucket release mechanism and raising the boom by means of the tractor power lift. The complete cleaner, it will be appreciated, is of exceptionally simple construction and equally simple to use. It can be used with any tractor having a power lift and after practice, it is possible to clear up to 50 yards of 6-ft. wide ditch in approximately half an hour.

PORTABLE ARC-WELDING SET

A new 150-ampere direct-current arc-welding set was included among the exhibits of A. C. Morrison (Engineers), Limited, Cliff Works, Burton-on-the-Wolds, Loughborough. This set is the first of a range of trailer-mounted units at present being developed by this firm and has been designed primarily for carrying out on-the-spot repairs. The prime mover is a Petter AVA, series II vertical two-cylinder air-cooled Diesel engine which develops 10 h.p. at 1,500 r.p.m. Alternatively, a Ford 10-h.p. industrial engine can be used as the prime mover. The generator, which is close-coupled to the engine, is a compound-wound machine, drip-proof protected and tropically impregnated. The control box, also drip-proof ventilated, is mounted on the generator; it incorporates a main welding-current selector switch and separate voltage and fine-current control. The unit is mounted on a strong two-wheeled trailer which has been designed to comply with road-traffic regulations for high-speed towing and is complete with brakes, mudguards and pneumatic tyres. It can be supplied either with a weatherproof sheet-metal canopy or a canvas hood. For workshop use, the unit is mounted on a strong trolley. The set has sufficient capacity for continuous welding of ½-in. plates.

MINIATURE LIGHTING SET

A. C. Morrison (Engineers), Limited, were also showing a miniature alternating-current lighting set which they have developed for lighting small houses, cottages, caravans, small boats, etc. The set is driven by a 98-c.c., 1·2-h.p. J.A.P. four-stroke petrol engine and the weight of the complete unit including fuel tank, base, etc., is 44 lb. It can, therefore, be transported from place to place with complete freedom. The output is 340 watts at 25 volts and it is claimed by the manufacturers that it can operate for ten to eleven hours on one gallon of fuel. It is fitted with four rubber anti-vibration mountings and a switch fuse and the design is such that, if required, the engine can be used as a power unit for driving such equipments as milking machines and pumps. The standard unit is fitted with a kick-start petrol engine but it can be provided with a petrol-paraffin engine. It can if required, also be supplied with a retractable starting handle.

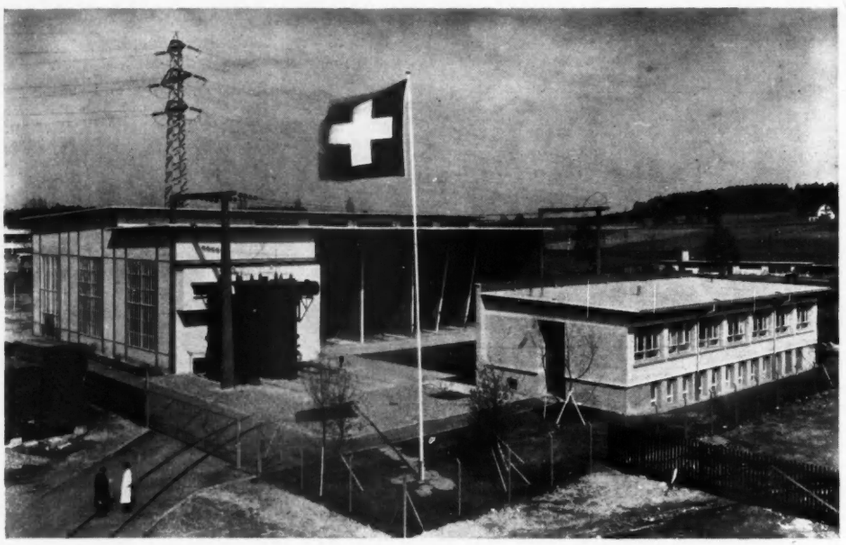

Fig. 1 General view of high-power circuit-breaker testing plant at Zürich with the machine room and test bays on the left and the observation and oscillograph building on the right.

HIGH-POWER CIRCUIT-BREAKER TESTING

NEW 1,500-MVA PLANT OPENED AT ZÜRICH

Since 1933 the Oerlikon Engineering Company, of Zürich, has operated a plant for the study of arc extinction and for testing complete circuit-breakers. This consisted of an alternator, designed for a making capacity of 1,000 MVA, and two transformers which enabled equipment to be tested at either 230 kV or 380 kV. The demand for increased rupturing capacity which has occurred in recent years has now led to the erection on a separate site of a new station, which was formally opened for service on Friday, June 25.

A general view of this new station is given in Fig. 1, which shows the machine room and test bays on the left and the observation and oscillograph building on the right. The 150-kV lines of the Zürich Electricity Works from which power is obtained and which can be used for line dropping tests on circuit-breakers, are visible in the background.

The present plant consists of an alternator with a making capacity of 1,500 MVA. The windings can be arranged in star or delta, as well as in series or parallel, and it is connected to a bus-bar system through a back-up circuit-breaker, reactors and a make-switch. Five branches from the bus-bar system lead to the same number of test bays, while a sixth is connected to two 1,300-MVA high-tension transformers, so that tests can be made at voltages up to 380 kV. Provision has been made for the installation of a second 1,500-MVA alternator and a third 1,300-MVA transformer, to bring the short-circuit capacity of the station up to 3,000 MVA. Another transformer and rectifiers enable direct-current short-circuit tests to be made at pressures up to 3,000 volts and with currents up to 80,000 amperes at 600 volts.

LAYOUT

As regards layout, the main building with the test bays is separated by a distance of 76 ft. from the oscillograph and observation rooms. The motor-driven alternator with its impulse exciter is installed in a machine room with the 6-kV switchgear, starters, reactors, 15-kV shunts and voltage dividers for the oscillograph in annexes. The circuit-breakers are prepared for test in an adjoining workshop from which they can be moved to the bays. The rectifiers are installed in a screened-off portion of this workshop, near which the direct-current tests are carried out. Outside one end of the workshops are the high-tension transformers from which a three-phase overhead line is run across the fronts of the test bays, as shown more clearly in Fig. 3.

ALTERNATOR DESIGN

The present short-circuit alternator is of comparable construction to a conventional two-pole machine and is designed to have an output of 3,500 amperes at a maximum voltage of 14 kV when running at 3,000 r.p.m. This maximum voltage is obtainable with the stator windings connected in series-star, the corresponding voltage for parallel-star being 7 kV. With the windings connected in series-delta, the maximum voltage is 8 kV and is 4 kV when they are arranged in parallel-delta. The necessary changes are made by bolted links which are mounted on a board in the basement. To ensure maximum output on short-circuit, both the transient and sub-transient reactances have been kept as low as possible and impulse excitation has been used. The synthetic-resin insulation used for the coil ends has been specially designed to resist the large electro-dynamical forces which occur on short-circuit, and to allow the expansion of the conductors, caused by currents of short duration. In addition, an automatic tightening device has been provided, which eliminates any play between the end connections. These connections are further supported to resist the torsional forces.

The slot conductors are of high-tensile copper alloy, which is insulated by a hard seamless material, and are laid radially.

Protective devices are provided which disconnect the alternator and exciter motors in the event of a fault on the alternator, as well as de-exciting the alternator and tripping the carbon-dioxide extinguishing apparatus. Doors in the ventilating system are also closed. The set is brought to rest by exciting the stator of the driving motor with direct-current from the auxiliary exciter of the impulse exciter and loading the rotor with its starting resistor. This resistor is moved automatically into the braking position once the set has run up to speed, so that it is always ready for use.

The alternator is driven by a 1,000-kW 6-kV motor, which is supplied from the mains. Both this unit and its exciter are mounted on a common reinforced-concrete block which is completely separated from the building.

EXCITATION ARRANGEMENTS

The impulse exciter set consists of two direct-current series-wound generators which are connected in series. They have a continuous rating of 1,200 amperes at 1,600 volts, the short-time overload capacity being 10,000 amperes. Both machines are driven by a 800-kW induction motor and are excited by an auxiliary exciter connected through a coupling which can be disengaged during operation. Immediately before the short-circuit is applied both the alternator and the exciter are disconnected from the network so that the total short-circuit power is supplied by the kinetic energy of the rotating parts. To enable the exciter to deliver the power for impulse excitation the rotational energy is increased by a flywheel of 237,000 lb.-ft.^{2} capacity. Impulse excitation is actually

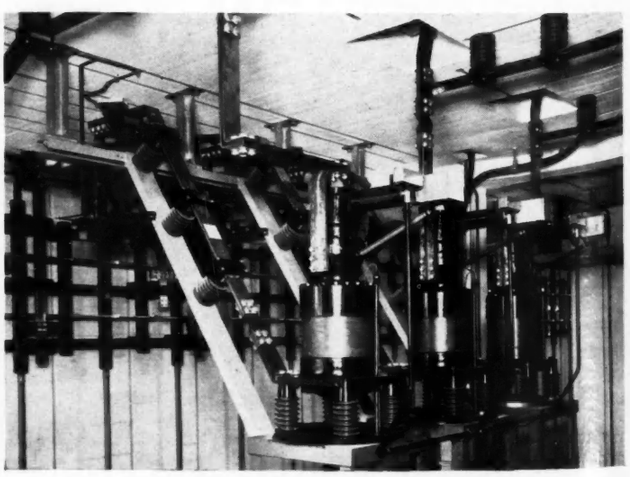

Fig. 2 Spring-operated compressed-air-charged make switch by which the test circuit is closed.

produced by bridging a resistor in the rotor circuit of the alternator, thus raising the voltage instantaneously to about 20 times the no-load value.

A sequence timing device enables the instant of short-circuit application to be selected, so that by closing each phase separately no current asymmetry occurs. By correctly selecting the moment at which the impulse excitation is applied the rate of decay of the short-circuit current can be reduced, so that the breaking capacity and making capacity are nearly equal. The maximum short-circuit current of the alternator can therefore be used and, owing to the absence of a direct-current component, breaking occurs at the exact time that the short-circuit is applied.

ELECTRICAL EQUIPMENT

The electrical equipment includes a back-up circuit-breaker, which comes into action if the circuit-breaker under test fails. It is of the reinforced air-blast type and is provided with low-resistance shunts to enable a rupturing capacity of 1,500 MVA at 14 kV to be obtained.

The short-circuit is applied by a make switch, which is illustrated in Fig. 2, and is designed to apply the short-circuit current at a predetermined point on the voltage wave. Bouncing on closure, which might cause burning or welding of the contacts, has been eliminated; and to ensure that the contact separation is a minimum when making a high air pressure is maintained in the chamber. The closing speed is rapid, so that the contacts are fully closed before the short-circuit current reaches its peak value, while to ensure that this speed is constant within close limits the switch is closed by springs of generous dimensions, which are loaded by compressed air.

To obtain the desired short-circuit current at any given voltage three reactors, the coils of which are built into separate concrete cells, are provided in each phase. These reactors may be connected in series or parallel and allow the short-circuit current to be adjusted to as low as 1 per cent. of the maximum.

Each bus-bar in the separate bus-bar systems consists of a double copper bar with a cross section of 10 × 100 mm., which is mounted on Orlite post insulators with a corrugated surface so as to withstand the high electro-dynamical forces. As the two bus-bar systems are separate it will be possible for the alternators to be run independently of each other.

Fig. 4 Observation and oscillograph room showing the openings through which the test bays can be observed. The sequence controller is in the glass-topped cabinet, the oscillograph equipment being on the extreme right.

TRANSFORMER AND TEST BAYS

At present, there are two 1,300-MVA single-phase transformers, although a third is to be added. By connecting the windings of these units in different ways it is possible to obtain voltages between 28 kV and 190 kV from each. Single-phase transformers were chosen so that testing could be continued on two phases if one failed. In addition, higher short-circuit current can be obtained during single-phase tests by connecting the two units in parallel. By connecting the two high-voltage windings in series and earthing the mid-point it is also possible to test circuit-breakers at 380 kV.

The equipment also includes a three-phase transformer, which can supply currents up to 200,000 amperes and is intended for testing low-voltage circuit-breakers and their contacts, as well as fuses. Direct-current is obtainable from a 9-MVA transformer and 12 single-anode rectifiers at voltages from 250 to 3,000 volts and currents up to 80,000 amperes.

Three shunts for current measurement are mounted in a separate room behind the test bays. These are connected close to the neutral point, which is earthed during measurements. The voltage is measured with resistive voltage dividers, the measuring resistances being directly connected to the oscillograph room.

The five test bays, of which two are for 14-kV equipment and the others for voltages from 30 to 380 kV, are of reinforced concrete. As will be seen from Fig. 3, they are open on the side facing the observation building. They can be connected directly to the alternator bus-bars so that tests with large short-time currents can be made without it being necessary to set-up the circuit-breakers again.

All the control equipment for the plant so far described is situated in a room on the first floor of the main building, which is arranged so that operations can be observed. The protection and supervisory apparatus, including the pressure pumps for the lubrication system and the switches for operating the carbon-dioxide equipment, are also installed in this room.

OBSERVATION ROOM

As already mentioned the observation room, of which a view appears in Fig. 4, is about 76 ft. away from the test bays. Its equipment includes two electromagnetic oscillographs, each of which has eight measuring elements for recording current, voltage, pressure, contact travel and other quantities. The rate of rise or natural frequency of the recovery voltage is recorded on a cathode-ray oscillograph. The test sequence and operation of the oscillograph is co-ordinated automatically by a motor-driven cam switch in the control desk. There will be a separate control desk for each alternator, the apparatus for governing their parallel operation being placed between them.

Short-circuit tests are initiated by closing the sequence switch, which then successively cuts out the driving motor, applies the impulse excitation and closes the make switch so tripping the test circuit-breaker. The timing of these operations is effected by adjustable segments on the circumference of the cams. After each test has been initiated the camshaft makes one complete revolution and then stops in its initial position. A time relay is provided for safety purposes. This supervises the operation of the sequence switch, trips all the circuit-breakers and stops the plant after an adjustable interval.

Normally only the maximum value of the alternating current component is of interest in circuit-breaker testing. Selectors, which can be connected in any phase, have therefore been provided on the sequence switches for controlling the make switch and the test circuit-breaker. After the sequence switch has made an approximate pre-selection, a thyratron selects the exact moment of switching. This thyratron is connected to a generator on the shaft of the main alternator, the instant of firing being determined within ± 1 electrical degree by a phase shifter in the circuit. These selectors can also be used for testing circuit-breakers with peak make currents, determining the maximum arc duration of air-blast circuit-breakers and making short-circuits tests with high current asymmetry. Communication between the test engineer and the control room in the machine house is by two-way loud speaker. The building also contains two dark rooms and offices.

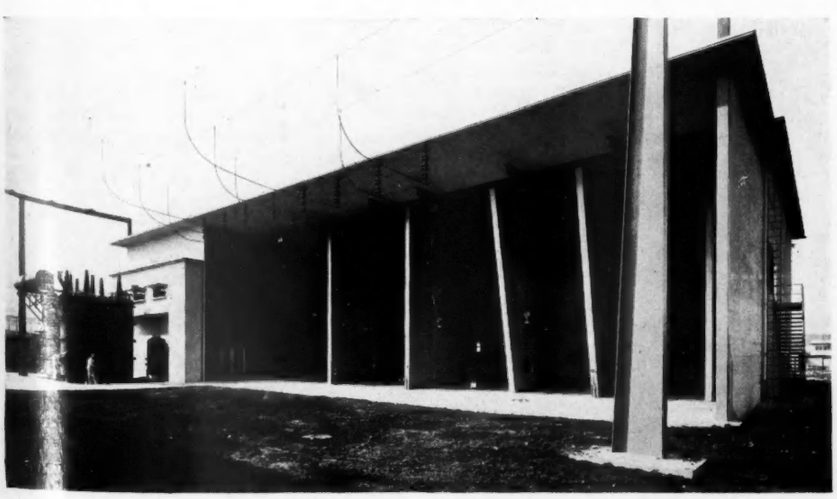

Fig. 3 View of the test bays at the new Oerlikon plant showing the transformers on the left and the supply lines above.

Labour Notes

FEWER DEMANDS FOR NATIONALISATION

Much of the preliminary agenda for the forthcoming annual conference of the Labour Party, published last Monday, is taken up by various aspects of foreign affairs and other matters of a strictly political character.

At last year's conference, a considerable amount of space on the agenda was occupied by demands for further nationalisation measures, but, on this occasion, only five resolutions on the subject have been submitted. Apart from one motion which asks, modestly, for the "nationalisation of all commerce and industry without compensation," the only fresh demands to be presented are for the public ownership of water-supply undertakings and municipal passenger-transport services.

As was only to be expected, however, there are, in addition, proposals for the re-nationalisation of the road-transport industry. These, no doubt, will receive considerable publicity and an appropriate share of the available debating time.

There are a number of resolutions on the agenda asking for an immediate increase in the level of pensions of various kinds, and many requests for a substantial reduction in the period of national service at present in force. Some of the constituency parties indicate that they are strongly in favour of the equalisation of coal prices throughout the country.

Two motions presented by constituency parties ask that the next Labour Government shall abolish commercial television. One of these proposes that all television programmes shall be under the control of the British Broadcasting Corporation.

The conference will be held at Scarborough and is due to be opened on September 27.

RISE IN RETAIL PRICES

There was an advance of one point in the level of the interim index of retail prices during the period between May 18 and June 15, according to an announcement by the Ministry of Labour and National Service on Tuesday. The index figure was back to 142 on June 15, the level at which it had previously stood on April 13. The figure on these two dates was the highest recorded since the index was introduced, in its present form, on June 17, 1947, when the level of prices was taken as 100.

More than usual fluctuation has taken place in the index during recent months. In mid-February last, the figure was 140, at which level it had remained stationary for seven months, but, on March 16, the figure advanced to 141, and, on April 13, it rose, by a further point, to 142. There was a decline by one point, to 141, between mid-April and May 18.

The rise in the index during the period ended June 15 was due mainly to increases in the average prices of eggs, fruit and vegetables, and to the higher prices obtained for coal in London and Southern England.

RAILWAYMEN SUPPORT LODGING TURNS

After discussing the question at some length, during a private session on July 15, delegates at the annual conference of the National Union of Railwaymen, at Gourock, decided, by a substantial majority, that lodging turns should continue to be accepted by the union's members.

The delegates re-affirmed the policy adopted by the union in 1949, when it was agreed to accept a limited increase in turns of duty involving lodging away from home, provided that the number was controlled by the union's national executive committee. This acceptance was accompanied, however, by a stipulation that enginemen employed at the various depots should be given an opportunity to examine all proposed new turns in advance, and to draw up alternative proposals if they so desired.

In a statement after the close of the debate on July 15, Mr. James Campbell, the union's general secretary, explained that, at the union's conferences in 1945 and 1947, the delegates voted against the introduction of additional lodging turns, and that this decision was reversed at a subsequent conference, in September, 1949, owing to the urgent need for increasing operating efficiency, and of effecting other economies in the railway service.

It may be recalled that demands for the discontinuance of these turns of duty have come, in the main, from engine crews on the Western Region, and that an unofficial strike by members of the Associated Society of Locomotive Engineers and Firemen against such duties took place last May and lasted for about a fortnight. Shortly afterwards, the union's delegates decided at their annual conference in London that their national executive committee should negotiate with the British Transport Commission for the total abolition of all lodging turns.

Now that the attitude of the N.U.R. has been determined, the position is likely to be reviewed in the near future at a joint meeting between representatives of both unions and the Commission.

WORK RESUMED AT NAVAL AIRCRAFT YARDS

Agreement was reached at a meeting of the Admiralty Industrial Council, in London, on July 15, that men involved in the strike at the Royal Naval aircraft yards at Sydenham, near Belfast, and at Donisbristle, near Dumfermline, Fifeshire, should return to work.

The stoppage arose out of a trade-union demarcation dispute at the Sydenham yard, where the Amalgamated Engineering Union withdrew some 300 fitters in May, on the ground that work previously undertaken by operatives belonging to that union had been allotted to members of another organisation.

On July 5, members of the A.E.U. employed at the Royal Naval aircraft yard at Donisbristle ceased work in sympathy and efforts were made later to bring out men engaged at the Admiralty's yard at Fleetlands, near Portsmouth.

The dispute concerned the erection of simple prefabricated metal racks and shelving for storage purposes, and had no connection with work on aircraft. The union claimed that this was work for fitters, but the Admiralty contended that it was performed at all its establishments by skilled labourers.

The agreement reached on July 15 provides that the question of the appropriate grade of employees to be used on the work shall be referred for settlement to a joint council, on which both the union and the Admiralty will be represented.

Both sides have given an undertaking that there shall be no victimisation of men who went on strike, or of those who remained at work.

STEELWORKS STRIKE ENDED

At the close of a brief meeting on Monday, the 300 coke-oven employees at the Margam steelworks of the Steel Company of Wales, Limited, who ceased work on July 5, announced that they had called off the strike. The stoppage, which was unofficial, arose out of a wage claim and had brought the company's Margam, Abbey, and Port Talbot works almost to a standstill.

On Monday, some three thousand steelworks employees were idle and steel production had ceased. Normally, the three works produce from 30 to 32 thousand tons of steel a week. The strike also threatened the supply of gas to industries and homes throughout West Wales and Glamorganshire.

Ovenmen receive substantially less pay than melters, blast furnacemen, and similar skilled grades, and their grievance lies largely in the fact that, although these craftsmen work only a 44-hour week, they are paid an incentive bonus. The ovenmen have for some time been claiming through their union, the Iron and Steel Trades Confederation, that a similar bonus should be paid to them.

There are no national agreements applicable to ovenmen and wage rates are negotiated by the union with individual firms. The employees at Margam have returned on the understanding that negotiations on their claim for a production bonus of 25*s*. a week shall be resumed. Discussions were in progress on the claim when the strike began. The company had made an offer of 5*s*. a week, which the men declined on the ground that it was insufficient.

A local official of the men's union stated after the decision had been taken to return that work had had to be resumed in order that negotiations might be continued. The men felt that they had proved all they wanted to prove in connection with the raising of their status and "their importance to the operation of the work."

PROGRESSIVE RESUMPTION OF WORK

Before reaching their decision to return, which was unanimous, the ovenmen were addressed by officials of their union and of the joint group representing the 20 unions having members employed at Margam. The ovenmen were assured of the support of the joint group for their bonus claim.

In a statement issued late on Monday, the company said that every effort would be made to bring the works back to a state of normal production as promptly as possible, but that, owing to the extent of the closure of the firm's production departments, this would necessarily take time.

Departments would come back into operation progressively throughout the remainder of the week. There would be a meeting between the management and representatives of the ovenmen, on Tuesday, to arrange a gradual intake of men to operate the ovens. Other meetings would be held between the two sides to discuss the steady resumption of the remaining departments.

Arrangements were also being made for the warming-up of the steel furnaces at Port Talbot and Margam works, but that was a process which took several days to complete. It was expected, however, that steel-ingot production could be commenced by the week-end, and that the rolling mill operation would resume shortly afterwards.

STEEL PLATE FOR SHIPBUILDING

In a written answer to a Parliamentary question on July 19, Mr. Duncan Sandys, the Minister of Supply, stated that the production of steel plate by British firms had been running, in general, at a somewhat higher rate during the first six months of this year, than had been the case during the corresponding part of last year.

Broadly speaking, Mr. Sandys added, he thought it could be said that the available supplies of steel plate were now sufficient to meet the current requirements of firms in the shipbuilding and ship-repairing industries.